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# Highway Safety Literature



U.S. Department of Transportation National Highway Traffic Safety Administration

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**SAE:** Society of Automotive Engineers, Dept. HSL, 400 Commonwealth Drive, Warrendale, Pa. 15096. Order by title and SAE report number.

**TRB:** Transportation Research Board, National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, D.C. 20418.



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## ABSTRACT CITATIONS

[illegible][illegible]

# CITATIONS

## ABSTRACT CITATIONS



HS-017 775

### **AUTOMOTIVE FUEL SAVINGS THROUGH SELECTED LUBRICANTS**

A vehicle track test, using 1975 model full-size sedans (with 350 cubic inch, V-8 engines), demonstrated increased gasoline engine fuel economy (0.5 to 2.7%) under both cold start and warm engine conditions when a selected combination of engine oils and power train lubricants were used. The engine oils, automatic transmission fluids, and rear axle lubricants were chosen based on engine dynamometer and road simulator screening tests. Significant fuel economy improvements (2.3%) for 10 W-40 oils over a 40 baseline were measured in steady state engine dynamometer tests. Synthetic base stocks did not improve fuel economy over mineral oil base stock for new engine oils in steady state laboratory dynamometer tests. Potential advantages of synthetics should be investigated. A special high density automatic transmission fluid showed improved fuel economy in steady state laboratory dynamometer and vehicle road simulator tests. Axle efficiency responded to lubricant viscosity and performance additive selection. A fuel economy track test showed greater fuel savings for selected lubricants under cold start conditions over warm engine conditions. Linear regression analyses of fuel economy variables showed significant ambient effects on fuel economy. Included as appendices are: the track test procedure; the fuel economy track test, predicted fuel consumption and ambient conditions; and test procedures for engine friction horsepower, automatic transmission fuel consumption, and engine fuel consumption for a 455 cubic inch V-8 engine, engine fuel consumption for the 302 cubic inch V-8 engine, road simulator fuel economy, and axle efficiency.

by William B. Chamberlin; Thomas J. Sheahan  
Lubrizol Corp.  
Rept. No. SAE-750377 ; 1975 ; 23p 13refs  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 776

### **PREDICTING THE SHEAR STABILITY OF MULTIGRADE ENGINE OILS FROM BENCH TESTS**

Engine oil shear stability data from six U.S. and two European car fleets have been obtained using 13 American Society for Testing and Materials (ASTM) Reference Oils. Four types of laboratory bench tests and three different laboratory tests were evaluated in the initial program. While several bench tests appear to be quite promising, none has been able to predict the shear stability of two problem oils, ARO-109 and ARO-106, satisfactorily. European cars, having a common oil charge for both the engine and the transmission, shear the oils substantially more than cars with separate engine and transmission sumps. Preliminary data indicate that the ability of the diesel injector rigs to predict the shear stability of an oil in service can be improved by operation at higher temperatures and higher pumping rates. Single-cylinder motored engines may be suitable for predicting the shear stability of an oil. Data obtained with a Tapered Bearing Stability Tester show a high degree of correlation with the fleet data from conventional cars. The ASTM shear stability program has shown that several laboratory methods can predict the shear stability of

an oil much better than the Sonic Shear Method, the one most frequently used. Closer ASTM cooperation with the Commission of the European Communities and the Institute of Petroleum would be beneficial. A calculation of repeatability and reproducibility from the analysis of variance results from single-cylinder motored engine tests is included.

by R. M. Stewart; M. L. McMillan  
Gulf Oil Corp., Gulf Res. and Dev. Co.; General Motors  
Corp., Res. Labs.  
Rept. No. SAE-750378 ; 1975 ; 16p 11refs  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 777

### **AUTOMATIC TRANSMISSIONS FOR PASSENGER COACHES [BUSES]**

Since the first passenger coaches were built in the 1900's coach manufacturers have sought better engine-transmission combinations and arrangements in order to improve performance, operation, and passenger convenience. The Detroit Diesel Allison has recently developed two new automatic transmissions, the HT 740 and the V730, for passenger buses. These transmissions each have two different versions which facilitate their usage with both diesel and gas turbine engines. The diesel engine versions use the hydraulic torque converter to provide good torque multiplication for vehicle start-up operation and to ensure smoothness during range shifts. The gas turbine versions use a clutch-coupling device which retains the ability to achieve turbine engine stall characteristics even when maintaining a minimum idle speed. Included are illustrations of various transmission types and graphs that demonstrate transmission characteristics.

by R. H. Schaefer; D. L. Robinson  
General Motors Corp., Detroit Diesel Allison Div.  
Rept. No. SAE-750381 ; 1975 ; 16p  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 778

### **A TEST PROCEDURE FOR EVALUATING TEMPORARY-SHEAR LOSS OF ENGINE LUBRICANTS**

Temporary shear loss characteristics of multigraded engine oils were measured in a newly developed engine (1972 455 cubic inch) oil pump rig. Test equipment consisted basically of a fluid sump, pump intake piping, motor-driven pump, oil filter, throttling valve, flow meter, and heat exchanger. Flow rate repeatability for the oil pump system was determined over the range of interest using various combinations of pump speed (500 and 1350 rpms) and discharge pressure (10, 22, 40, and 60 pounds per square inch) at 210F. The oil pump rig was calibrated using various Newtonian oils. It is concluded that: the temporary shear loss within the polymethacrylate family of VI improvers increases smoothly with increasing molecular weight; when comparing various types of polymer chemistry, there is no relation between permanent and temporary shear characteristics of VI improvers; the degree of temporary shear

HS-017 779

loss of VI improvers may either increase or decrease with the temperature, depending on polymer chemistry; and high temperature, high shear viscosity is a function of the combined effects of kinematic viscosity and temporary shear loss effects.

by R. L. Stambaugh; R. J. Kopko  
Rohm and Haas Co.  
Rept. No. SAE-750379 ; 1975 ; 11p 22refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 779

### A JOINT VENTURE OF RECYCLING IN PLANT WASTE OILS

A joint venture by the Chrysler Corporation and the Booth Oil Company for recycling waste oils is discussed. A historical description of the plant (from which the oil is recycled) facilities and operations from 1960 to 1965 (the year the joint venture was conceived) is provided and subsequent plant expansions and improvements are described. The logistics and economics of the joint venture are also considered. Several benefits have been derived: a legal and ecologically sound means of waste oil disposal; a definite cost saving in product procurement; increased pump life because of improved antiwear characteristics of the re-refined oil; and a guaranteed source of supply.

by Joseph A. Oster; George T. Booth, Jr.  
Chrysler Corp.; Booth Oil Co., Inc.  
Rept. No. SAE-750388 ; 1975 ; 6p 2refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 780

### WASTE OIL MANAGEMENT FROM SUMP TO END USE--A STATUS REPORT

Waste oil recovery practices are discussed and evaluated. The following aspects of waste oil production, disposal, and/or use are considered: oil use and consumption; waste oil output; waste oil as a fuel; reason for reprocessing lubrication oils; waste oil reprocessing; problems involved in recovering and reprocessing; and goals for the future. Calculations are provided for: waste oil input and output by use (millions of gallons per year); typical waste automotive oil composition; waste oil physical and chemical analysis; and waste oil re-refining process comparison (for the acid/clay process, the solvent extraction/acid/clay process, the distillation/clay process, and the distillation/hydrotreat process).

by Peter B. Lederman  
Environmental Protection Agency  
Rept. No. SAE-750387 ; 1975 ; 8p 27refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 781

### AIR CONDITIONING--THE INTEGRATED SYSTEM

Environmental control system components and their effect on air-conditioning as an integrated system are reviewed. The

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evolution of cooling systems, system requirements, the air-flow, and the refrigerant cycle are discussed. Sample calculations for the design of a theoretical air conditioning system (for the evaporator, motor blower, compressor, condenser, expansion valve, and the real air-cooling system) are provided. With the increasing usage of integral environmental-control systems providing heating, cooling, and dehumidification, it is necessary to use the full-system approach in the design.

by Ronald J. Brooks  
Kysor Industrial Corp., Kysor of Byron Div.  
Rept. No. SAE-750401 ; 1975 ; 7p 3refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 782

### AN EVALUATION OF TRANSIT BUS AIR CONDITIONING SYSTEMS

A study conducted to evaluate present transit bus air conditioning systems and to present some concepts for future vehicles is presented. Various cooling load requirements are examined and related to present air conditioning systems. Vehicle tests are conducted in test cells where ambient temperature may be regulated. Water tanks with immersion heaters (for latent heat) and light bulbs (used for sensible heat) are distributed throughout the vehicle interior and may be adjusted to any desired vehicle interior temperature and humidity conditions. Thermocouples are located at numerous locations in the vehicle including head level, seat level and floor level at driver's compartment, front, center and rear of vehicle. The engine is operated at four different speeds: low speed idle (450 rpm), high speed idle (800 rpm), mid-range (1500 rpm), and high speed (2150 rpm). The effects of air ducting and temperature distribution are evaluated and suggestions are presented for improving both items. Recommendations are made for going to a dual ducting system or a more desirable compromise for air ducting. Also discussed is the need for decoupling the compressor from the engine because of the levels of vibration generated from the engine. It is suggested that V velting would accomplish this and would allow for the compressor to be driven at different speeds.

by Ronald D. Lemke  
Thermo King Corp.  
Rept. No. SAE-750402 ; 1975 ; 11p 3refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 783

### THE ROVAC AUTOMOTIVE AIR CONDITIONING SYSTEM

A new automotive air conditioning system (the ROVAC system), a combination rotary compressor/expander unit that employs air as the refrigerant, is described. Prototype modeling, design, fabrication, laboratory testing, and field testing in a full size four door 1973 Dodge Coronet are presented. Schematics of the ROVAC system are provided. It was found that the prototype system installed in the Coronet produced delivered cooling capacity on the order of one to one and a half tons per thousand rpms and delivered coefficients of performance at relatively high humidity levels (150-180 grains of

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water per pound of dry air) rivaling the best developed conventional vapor compression air conditioning systems. During actual in-car jury tests, the prototype ROVAC air conditioning system brought the average passenger compartment temperature from a thermally soaked condition of 107 F down to 72 F in less than two minutes with five passengers at an average road speed of 30 mph.

by Thomas C. Edwards  
Rovac Corp.

Rept. No. SAE-750403 ; 1975 ; 11p 3refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 784

### **COST AND ENERGY CONSERVATION WITH POWDER METALLURGY**

The application of the P/M and P/F methods of powder metallurgy in the production of automotive parts is investigated and compared to the conventional methods of costing and forging, with special attention paid to the areas of cost and energy conservation. The cost and energy consumption of P/M parts is considered for the timing chain sprocket and the transmission clutch hub. The cost and energy consumption of P/F parts is considered for connecting rods and the differential pinion. The feasibility of producing heavy parts by the P/M method is discussed. It is concluded that: for light parts (200-500 grams), significant cost and energy savings can be realized by using the P/M method; the P/F method using pure iron powder to make light parts has these same advantages, but the P/F method using alloyed steel powder does not have any cost benefit; in heavy parts over 800 grams there is no cost advantage in using the P/M method; and in order to make it possible and practical to produce heavy parts by the P/M method as well as relatively light gears by the P/F method, a low cost powder must be developed.

by K. Imahashi; T. Suzuki; C. Tsumiki  
Toyota Motor Co., Ltd. (Japan)  
Rept. No. SAE-750409 ; 1975 ; 10p  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 785

### **THE ECONOMICS OF CONVENTIONAL P/M [POWDER METALLURGY] PARTS PRODUCTION IN THE U.S.**

Information on powder metallurgy (P/M) process costs are presented so that the manufacturing costs for P/M parts might be estimated. Estimating steps include: examining the proposed P/M part (mechanical properties, anti-corrosion provisions, assembly methods, operating temperature, electric or magnetic properties, secondary machining, and hardening and carburizing); general design considerations (design guide, and tolerances); material costs and average part costs; cost estimate form; costs for specific operations (raw materials, pressing or molding costs, sintering costs, coining and repressing charges, machining costs, heat treating costs, finishing operations and quality control); and tooling costs. Some design guide illustrations, cost statistics, and a sample cost estimate form are presented. A graded series of illustrated

parts, of increasing complexity, is provided so that tooling costs for prospective parts can be estimated by comparison with these examples.

by Leander F. Pease, 3rd  
Powder-Tech Associates, Inc.  
Rept. No. SAE-750410 ; 1975 ; 22p  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 786

### **SULFURIC ACID EMISSIONS FROM AN OXIDATION-CATALYST EQUIPPED VEHICLE**

A 1973 Ford Torino with 351 cubic inch V8 engine and 1975 emission controls including monolithic noble metal catalysts was used to examine the effects of vehicle operating variables on sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) exhaust emissions. The vehicle was operated with or without catalysts on a chassis dynamometer, at 60 mph and on an urban driving cycle (the 1975 Federal Test Procedure). Sulfur dioxide and H<sub>2</sub>SO<sub>4</sub> were collected by a condenser coil with hydrogen peroxide bubblers in series sampling from a dilution tunnel. Filter samples were collected from the tunnel for total particulate mass, sulfate, and pH measurements. The size distribution of the exhaust sulfate particulates was investigated by cascade impactor. It was found that: at 60 mph, 36% of the fuel sulfur was emitted as H<sub>2</sub>SO<sub>4</sub>; on the urban driving cycle, the figure was 10 to 24% depending on prior operating history, with small differences between cold and hot-start and between transient and stabilized phases of the cycle; sulfur storage in the converter was minor; the emitted H<sub>2</sub>SO<sub>4</sub> was composed primarily of droplets smaller than 0.3 micrometers; and without catalysts, emission of H<sub>2</sub>SO<sub>4</sub> is less than one percent of the fuel sulfur.

by Frederick A. Creswick; Ellsworth R. Blosser; David A. Trayser; John F. Foster  
Battelle's Columbus Labs.  
Rept. No. SAE-750411 ; 1975 ; 12p 15refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 787

### **CONTROL OF THE SUBWAY ENVIRONMENT**

Environmental control in the subway portions of rapid transit systems is discussed. Some earlier rapid transit systems (New York, Boston, Chicago, and Toronto) are considered and some of the new generation of rapid transit systems (the San Francisco Bay Area Rapid Transit System, the Port Authority Trans Hudson System in New York and New Jersey, and systems in Montreal, Canada, Atlanta, Georgia, Washington, D.C., and Caracas, Venezuela) are discussed. The United States Department of Transportation's Subway Environment Research Project, established to develop a handbook for use by subway system planners, operators and designers, is described. The project is explained in terms of: the environmental criteria to be considered; the analysis of where the heat is in the system and how the airflow created by the piston effect of trains and fans serves to dissipate this heat and influence the thermal load (manual computation, computer evaluation, input-output, validation, and testing); and control of environment. The application of environmental controls to one rapid transit system, the Metropolitan Atlanta Rapid Transit Authority, is considered.

by Arthur G. Bendelius  
Parsons, Brinckerhoff, Quade and Douglas, Inc.  
Rept. No. SAE-750439 ; 1975 ; 10p 6refs  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 788

### USE OF ALUMINUM IN AUTOMOBILES--EFFECT ON THE ENERGY DILEMMA

The effect of the use of aluminum in automobile production on energy consumption is discussed. The reduction of vehicle weight through the use of lighter materials includes: a primary saving resulting from the direct substitution of a lighter for a heavier material in a component; and a secondary weight saving resulting from the lighter structural loads to be carried by the chassis and suspension systems. The relationship between fuel economy and weight is considered. The following calculations are presented: estimated average usage of aluminum in passenger cars (1974, 1980, and 1985); estimated weight of replaced materials and total weight saved (1974, 1980, and 1985); estimated fuel savings per pound of weight reduction (lifetime fuel savings by vehicle class); lifetime fuel savings with 10% weight reduction; a comparison of the energy content of aluminum versus heavier metals; the energy content of materials used in automobiles; and the estimated energy savings with aluminum components in a car's lifetime. Over the life of a 1974 intermediate class automobile, equivalent Btus of gasoline energy saved range from 325,000 to 500,000 Btus per pound of aluminum used. The saving is: 5.3-8 greater than the energy required to produce one pound of aluminum; 11-28 times greater than the additional energy required to produce aluminum instead of replaced material; and 65-98 times greater than the energy required to recycle one pound of aluminum.

Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096  
Rept. No. SAE-750421 ; 1975 ; 8p 12refs  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 789

### MASS TRANSPORTATION VEHICLES AND PEOPLE MOVERS

An overview of developments in mass transportation vehicle and people mover design is presented and the constraints facing the industrial designer are illustrated. Specific transportation design projects are discussed: San Francisco Bay Area Rapid Transit (BART) interior section design; BART prototype design; Long Island Railroad (RR) production car design; Boeing lightweight rail vehicle design; front end design for BART, the Long Island RR, and systems in Baltimore, Maryland and Rio de Janeiro, Brazil; the interior design of the proposed Las Vegas people mover; and the designs for various state-of-the-art cars (low density floor plan and interior arrangement, and high density floor plan and interior arrangement). Also discussed are: the Rio de Janeiro transit car (floor plan, and interior seating arrangement); BART interior seating arrangement; the R-44 subway car seat in New York City; and interior lighting (BART lighting diagram, and MARTA (Atlanta, Georgia system) interior ceiling.

by Richard A. Heck  
Sundberg-Ferar, Inc.  
Rept. No. SAE-750440 ; 1975 ; 11p  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 790

### HIGHLIGHTS OF UMTA'S RAIL PROGRAM

The rail research programs of the Urban Mass Transportation Administration (UMTA) are discussed. Descriptions of several recently developed commuter transit cars are included: the state-of-the-art car (a baseline definition of the possibilities in rapid transit car design using available hardware); the Advanced Concept Train; and dual-powered, gas turbine/electric cars. Developments in light rail vehicles (streetcars) are also considered. UMTA's test facilities in Pueblo, Colorado, and tunneling and noise abatement research are briefly described.

by Joseph S. Silien  
Department of Transportation  
Rept. No. SAE-750441 ; 1975 ; 6p  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 791

### BART PROGRESS REPORT

The concept of the San Francisco Bay Area Rapid Transit program (BART) and the major experiences translating that concept to its present operation in revenue service are described. The following of BART development are discussed: the engineering plan and the public vote; the Diablo, California test track; construction of BART; prervenue testing and present equipment; revenue service; and the present situation. As the level of service of BART (at present, only 14 hours per day, 5 days per week) improves, patronage is expected to increase significantly.

by W. P. Quintin, Jr.; T. S. Eanes  
Bechtel, Inc.  
Rept. No. SAE-750442 ; 1975 ; 10p  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 792

### MASS TRANSPORTATION: A NATIONAL COMMITMENT

The need for a national commitment to public transportation and the need for legislative action to provide stable long term funding are emphasized. Bus and rail transit and personal rapid transit are briefly discussed. It is concluded that the task of attracting 25% of the urban trips by 1990 to public transit is within reach and can be done at a cost comparable to a \$0.05 per gallon motor vehicle fuel tax or \$22 per person per year.

by T. A. Lancaster; D. L. Hearn  
Rohr Industries, Inc.  
Rept. No. SAE-750443 ; 1975 ; 8p 4refs  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 793

**SIMULATION STUDIES FOR AN URBAN TRAFFIC CORRIDOR. FINAL REPORT**

The salient features of the Simulation of Corridor Traffic (SCOT) model and a successful calibration and validation are described. SCOT is a computer model applicable to an urban traffic corridor and capable of simulating vehicular traffic on freeways, including on and off ramps, and urban streets. Vehicles are treated microscopically on the arterial street system and macroscopically as platoons on the freeway. Output statistics for each simulated link include numbers of vehicles discharged, total times of travel, average occupancy, and average speeds for specified time intervals. Calibration and validation data collected using photographic techniques on a 1.2 mile test network of the Dallas North Central Expressway are described. Tests showed no significant differences between field and simulation results at the 1% level of significance for the basic parameters of traffic (mean speed, flow and saturation). This and other applied tests indicate that the SCOT model adequately replicates freeway traffic performance. A demonstration of the origin-destination (O-D) traffic assignment capability of the model is described (using license plate data recorded at the frontage road and at each ramp on the test network). It is indicated that the minimum time-path criteria used have not been conclusively shown to be the correct criteria for origin destination traffic assignments. An analysis of freeway ramp control versus no ramp control for the Dallas test network shows a statistical reduction in speed with no ramp control for those freeway links in the vicinity of the on-ramp.

by Lawrence McCabe; Robert Ricci; Patricia Concannon  
Department of Transportation, Transportation Systems Center,  
Kendall Square, Cambridge, Mass. 02142  
Rept. No. DOT-TSC-FHWA-75-2 ; 1975 ; 47p 9refs  
Report for July 1973-June 1975. Sponsored by the Federal  
Hwy. Administration.  
Availability: NTIS

HS-017 794

**THE ROLE OF HELICOPTERS IN EMERGENCY MEDICAL CARE SYSTEMS**

The Department of Transportation's guidelines of June 27, 1967, directed each state to provide an up-to-date comprehensive plan for emergency services. The standard requires the states to provide: training and licensing requirements for rescue workers; requirements for types and numbers of emergency vehicles as well as supplies and equipment; requirements for operation and coordination of emergency care systems; first aid courses and refresher courses for emergency personnel; and criteria for use of two-way communications as well as procedures for summoning and dispatching aid. As of March 31, 1971, only 16 states had taken steps to meet these standards. By some estimates 20% of the deaths (in 1968) would not have occurred if there were adequate emergency care. After an accident occurs, there are three critical factors that determine the life or death of a victim: the time between the accident occurrence and the delivery to a facility capable of extensive life-saving treatment; the first aid treatment of the victim at the scene of the accident and during transport; and the treatment at the hospital. The possibility of using helicopters as rescue vehicles is explored. The helicopter should be used as a supplement to and not a replacement for existing ground ambulance systems. The annual average

operating cost of a helicopter is three times that of the conventional ambulance. In a rural environment the helicopter's primary mission should be emergency and evacuation. Of secondary importance are law enforcement and traffic safety activities. In an urban environment the priorities are reversed. A helicopter, if used properly, can be cost effective in urban and rural areas. The general public is receptive to the use of helicopters in rescue work.

by David P. Skogman  
USAMC Intern Training Center-USALMC Attn: AMXMC-  
ITC-E-S, Red River Army Depot, Texarkana, Tex. 75501  
1971 ; 51p 33refs  
Master's Thesis, Texas A and M University.  
Availability: NTIS

HS-017 795

**DRIVER VISUAL NEEDS IN NIGHT DRIVING.**

A variety of research projects related to driver visual needs in night driving are reported. A progress report on research into night visibility and under different systems of fixed roadway lighting is presented. Visibility losses caused by transient adaptation at low luminance levels are discussed. The development of a headlight evaluation model is reported. Contrast requirements of urban driving are examined and driver search and scan patterns investigated. Field and computer-simulation methods for evaluation of head lamp beams are developed and compared. Driver screening behavior and visual needs for night driving are examined. Lighting research conducted at the United Kingdom Transport and Road Research Laboratory is reported. An investigation of fixed illumination as a function of driver needs is discussed and various priorities and recommendations with regard to the implementation of research results are presented.

by Marjorie Moore, ed.  
Transportation Res. Board, Washington, D.C.  
Rept. No. TRB-SR-156 ; 1975 ; 124p refs  
Proceedings of a symposium conducted at Ohio State Univ., 4-6 Sep 1974. Sponsored in part by Illuminating Engineering Res. Inst., Ohio State Univ., and Ohio Dept. of Transportation.  
Includes HS-017 796--HS-017 805.  
Availability: Corporate author \$5.00

HS-017 796

**NIGHT VISIBILITY UNDER DIFFERENT SYSTEMS OF FIXED ROADWAY LIGHTING: A PROGRESS REPORT**

The visibility of objects on the roadway at night has been studied under different conditions of fixed lighting and pavement reflection in a 15 to 1 scale model of a divided urban freeway. Visibility was measured in accordance with the quantitative methods described by the International Commission on Illumination, involving psychophysical measurements of equivalent contrast and physical measurements of disability glare and luminance. Initially, three realistic targets were studied at 20 foot intervals throughout the luminaire cycle down the center of each of eight lanes, under six layouts of model luminaires. Average results indicated that visibility did not increase so much with increases in illuminance as was expected. Also, when the spacing of luminaires was wide, variability in visibility was great. These results were attributed to an anticamouflage effect of roadway luminance nonuniformities. Subsequent research with identical targets (three manikins and

four two-dimensional rectangular targets) of different reflectances confirmed this and indicated that the visibility potential of different pavements and lighting systems should be based on visibility measures of targets of the normal reflectances weighted in proportion to the frequency of their occurrence. The quantity of data needed for this purpose implies need for a physical correlate of target visibility. Target visibility can be predicted reasonably well from roadway luminance and the arithmetic average of the local contrasts of different parts of a target with adjacent portions of the roadway background. It now seems possible to compute indices of visibility potential for different roadway environments. Further work is needed to assess transient adaptational effects and individual differences in visibility threshold.

by O. Mortenson Blackwell; H. Richard Blackwell  
Ohio State Univ., Inst. for Res. in Vision  
Publ: HS-017 795 (TRB-SR-156), Driver Visual Needs in Night Driving, Washington, D.C., 1975, p1-10  
1975 ; 6refs  
Presented at a symposium conducted at Ohio State Univ., 4-6 Sep 1974. Supported in part by the Ohio Dept. of Transportation and the Federal Hwy. Administration and in part by the Illuminating Engineering Res. Inst.  
Availability: In HS-017 795

HS-017 797

#### VISIBILITY LOSSES CAUSED BY TRANSIENT ADAPTATION AT LOW LUMINANCE LEVELS

Experiments were conducted concerned with driver transient adaptation at luminance levels approximating moonlight and outdoor lighting conditions and examining the effects of luminance nonuniformities on transient adaptation and simulating a roadway problem. A free-viewing system was used in which the subject, head positioned, looked through a pellicle beam splitter at a background field illuminated by two slide projectors on which test letters of varying illuminations were shown. It was found that at low luminance levels, sudden increases produce losses in visibility equivalent to those previously found at higher luminance levels. However, at low luminance levels, decreases produce smaller losses than those observed at higher luminance levels. The results also suggest that there is a preadapting level or range of levels below which there is little or no difference between visibility losses for 10- and 100-fold decreases and above which there is a difference. The transition appears to be a gradual one and is complete at about 8 foot-Lambert. The findings of these investigations suggest that visibility loss depends more on the ratio of steady-state thresholds, particularly at low luminance levels, than on the ratio of luminance change as previously supposed. Research has been initiated on the problem of nonuniformities in roadway luminances in the motorist's visual environment. Results indicate that the size of a nonuniformity may have little effect on transient adaptation. However, experiments to examine multiple nonuniformities and the effect of nonuniformities at various distances from the line of sight on transient adaptation are planned.

by Edward J. Rinalducci; Arthur N. Beare  
University of Virginia  
Publ: HS-017 795 (TRB-SR-156), Driver Visual Needs in Night Driving, Washington, D.C., 1975, p11-22  
1975 ; 14refs  
Presented at a symposium conducted at Ohio State Univ., 4-6 Sep 1974. Supported by the Illuminating Engineering Res. Inst.  
Availability: In HS-017 795

HS-017 798

#### DEVELOPMENT OF A HEADLIGHT EVALUATION MODEL

A research program now in progress has as its goal the development of a head lamp evaluation model. The model will evaluate headlight systems in terms of a single overall figure of merit representing several measures of driver visual performance under night driving conditions. The test route is a computer simulation of a series of highway sections incorporating environmental factors that influence driver visual performance, including topography, reflectance and ambient brightness of the road and road elements, highway type, traffic characteristics, target characteristics, and weather. The model incorporates a seeing distance model that determines the photometric conditions produced by vehicle lighting and environmental factors and computes the glare and seeing distance to pedestrian and pavement delineation targets. The seeing distance and glare calculations used in the seeing distance model are derived from laboratory formulations of human vision capabilities. A program of field research has been initiated to verify the seeing distance model and to provide data for the simulation of those aspects of the nighttime highway environment that determine head lamp illumination of target and pavement and, hence, visual performance.

by Eugene Farber; Vivek Bhise  
Ford Motor Co.  
Publ: HS-017 795 (TRB-SR-156), Driver Visual Needs in Night Driving, Washington, D.C., 1975, p23-39  
1975 ; 13refs  
Presented at a symposium conducted at Ohio State Univ., 4-6 Sep 1974. Prepared in cooperation with David E. Naurer.  
Availability: In HS-017 795

HS-017 799

#### CONTRAST REQUIREMENTS OF URBAN DRIVING

Research conducted in an effort to develop a technique for quantifying and specifying the visibility needs of urban drivers in a manner consistent with state-of-the-art lighting engineering capabilities and practices is reported. The empirical relationship between a measure of driver visual performance and several methods of quantifying visibility is explored in an effort to develop roadway lighting specifications based on visibility needs. Physical contrast, equivalent contrast, relative contrast sensitivity, and glare exposure were investigated. Field measurements of the visual performance of 941 unalerted motorists (on a six lane, 1,800 foot test site with 18 inch targets placed at 50 foot intervals in one of the lanes) were analyzed and a precise method of quantifying visibility was identified. The critical measure of driver visual performance was the time separation between the vehicle and a target when an evasive response was initiated. The following conclusions were reached: for a simple target, pure contrast ratio predicts driver visibility with considerable accuracy; the influence of glare is largely differentiated under the lighting conditions tested; and spot background luminance is a good predictor of adaptation level given the luminance variability reported on here. The suggested visibility index uses physical contrast, contrast sensitivity, and a disability glare factor. A method of prescribing visibility in terms of safe stopping requirements is examined. Follow-up research that will enhance the reliability of the measures, extend the general applicability of the concept, and further develop the prescription approach, is outlined.



May 31, 1976

HS-017 802

by Vincent P. Gallagher; Patrick G. Meguire  
Franklin Inst. Res. Labs.  
Publ: HS-017 795 (TRB-SR-156), Driver Visual Needs in Night  
Driving, Washington, D.C., 1975, p40-52  
1975 ; 7refs  
Presented at a symposium conducted at Ohio State Univ., 4-6  
Sep 1974.  
Availability: In HS-017 795

HS-017 800

### DRIVER SEARCH AND SCAN PATTERNS IN NIGHT DRIVING

Two studies of driver eye movements in night driving were conducted using television cameras and an infrared corneal movement pickup system: one to describe driver eye movement pattern during night driving and to compare them to daytime patterns on freeways and a rural highway; and another to determine differences in visual search behavior at sites with high and low night accident rates and the effects of illumination on drivers' visual search. In the first study four college males drove on three routes in both day and night conditions, and six college males performed 128 separate intersection passes at three high night accident, three low night accident, and three sites where the lights could be turned off in the second study. The results show that measures of driver visual search patterns are sensitive to day and night differences, to sites with different accident rates, and to illumination. The results from the highway intersections with illumination lend encouragement to using eye movement data to evaluate methods of improving nighttime driving. It was found that at illuminated sites drivers spend less time viewing the scene left, decrease the mean look time per area, which may indicate shorter times to acquire information, and increase the mean time viewing the scene ahead, the area where guidance control information is concentrated. The methodologies developed in these studies should be extended to evaluate the effects of illumination at sites with high night accident rates and to evaluate alternate methods of improving nighttime driving, such as improved pavement markings, signing, signalling, and reflectors.

by Nick J. Rackoff; Thomas H. Rockwell  
Pennsylvania State Univ.; Ohio State Univ.  
Publ: HS-017 795 (TRB-SR-156), Driver Visual Needs in Night  
Driving, Washington, D.C., 1975, p53-63  
1975 ; 29refs  
Presented at a symposium conducted at Ohio State Univ., 4-6  
Sep 1974.  
Availability: In HS-017 795

HS-017 801

### FIELD AND COMPUTER-SIMULATED EVALUATION OF HEAD LAMP BEAMS

The development of targets for use in field tests to measure visibility distances of drivers and to evaluate head lamp beams is described. Targets evaluated included vertical, up/down, and choice position targets. The pedestrian target used consisted of a sheet of plywood, 16 inches wide and 72 inches high, painted a flat gray for reflectance values of 14 and 22 percent. In the visibility evaluations, the targets were located at the right edge of a flat road and an automobile was driven toward them. There was no opposing traffic. The driver's task was to depress a switch when he detected the target or made the appropriate discrimination, which allowed the visibility distance

of the target to be measured. The test procedure used (four subjects in two sets of eight test runs) appears to have satisfactory statistical reliability and provides discriminations in the visibility distances attributable to variations in head lamp beams. Tests to evaluate glare effects to opposing drivers and those due to reflections in mirrors from the head lamps of a following vehicle were also conducted. A computer simulation model that predicts visibility distances and glare effects was developed and its validity was established by comparing computer predictions with the field test results. The model has a variety of applications that can provide insights into the influence of many variables on visibility distances and glare. Such applications include the evaluation of the effectiveness of various meeting beams on targets located at the right and left of the lane and at various degrees of head lamp misalignment and the prediction of visibility distances in vehicle meetings on roads having horizontal or vertical curvature and the effects on visibility distances of the head lamps of a following car reflected in interior and exterior mirrors.

by Rudolf G. Mortimer  
University of Illinois at Urbana-Champaign, Dept. of Health  
and Safety Education  
Publ: HS-017 795 (TRB-SR-156), Driver Visual Needs in Night  
Driving, Washington, D.C., 1975, p64-73  
1975 ; 13refs  
Presented at a symposium conducted at Ohio State Univ., 4-6  
Sep 1974.  
Availability: In HS-017 795

HS-017 802

### DRIVER SCREENING FOR NIGHT DRIVING

A thorough review of the relevant literature was combined with a systematic examination of the driving task to derive a set of visual functions important to the driving task. The functions included both static and dynamic measures, containing both sensory and perceptual aspects. A device was developed to test performance on these functions, including three measures related to night vision: static acuity under low levels of illumination, in the presence of veiling glare, and under spot glare. The battery of tests was administered to a total of 669 passenger car drivers and 235 truck and bus drivers. Three-year driving records were obtained for all subjects and were examined in relation to performance on the vision tests. Because no data on night accidents were available, an adequate evaluation of the night-vision-related tests was not possible. However, the results showed a high degree of variability in visual acuity performance obtained under conditions similar to those encountered in night driving and also showed that acuity measured under normal light conditions does not adequately predict acuity under typical night driving conditions. Results of the tests showed that: age had a dramatic effect on acuity; performance on the spot and veiling glare tests was very much alike within each age group; the range of acuity performance within each age group increased dramatically under low illumination and in the presence of glare; and truck and bus drivers reacted to the adverse effects of low illumination and glare as did passenger car drivers, in spite of the fact that the acuity test procedure was significantly modified for administration to truck and bus drivers. Efforts are now underway to construct a feasibility prototype of a Mark II device that will automatically administer and score tests that measure: static acuity and static acuity both under a low level of illumination and in the presence of spot glare; the ability to detect, acquire, and interpret acuity targets randomly presented over a field measuring 30° laterally by 20° vertically; the ability

to detect angular movement in the central field and in the peripheral field; the ability to detect movement in depth in the central field; and the field of vision.

by R. L. Henderson; A. Burg  
National Hwy. Traffic Safety Administration; University of California, Los Angeles  
Publ: HS-017 795 (TRB-SR-156), Driver Visual Needs in Night Driving, Washington, D.C., 1975, p74-89  
1975 ; 21refs  
Presented at a symposium conducted at Ohio State Univ., 4-6 Sep 1974. Supported by two Dept. of Transportation contracts. Availability: In HS-017 795

HS-017 803

### LIGHTING RESEARCH AT THE U.K. TRANSPORT AND ROAD RESEARCH LABORATORY

Work is underway to establish the relationship between road light levels and accidents. The research involves extensive measurements of light levels and detailed recording of accident data. These will be supplemented by the findings of studies of near accidents (conflicts) recorded at specific sites, which should indicate the effectiveness of both conventional and experimental lighting schemes. Nighttime driving is particularly difficult on wet roads, and therefore a photometric evaluation of all types of surfaces both wet and dry is being undertaken to provide physical measurements relating to the problem. Vehicle lighting research is mainly concerned with the investigation of headlight glare-reducing techniques. These include the possible use of dimmed headlight beams as presence indicators in lighted areas, median glare screens, and special low-glare head lamps. A study of the merits of the low-beam lamp patterns developed in Europe and in the United Kingdom and the United States revealed little overall advantage for either, but showed that there was a considerable problem resulting from head lamp misaim due to vehicle loading. Head lamp self-levelling systems have been developed to compensate for this loading factor.

by Alexander Irving; J. Stuart Yerrell  
Transport and Road Res. Lab., Crowthorne, Berks.  
Publ: HS-017 795 (TRB-SR-156), Driver Visual Needs in Night Driving, Washington, D.C., 1975, p90-100  
1975 ; 12refs  
Presented at a symposium conducted at Ohio State Univ., 4-6 Sep 1974.  
Availability: In HS-017 795

HS-017 804

### FIXED ILLUMINATION AS A FUNCTION OF DRIVER NEEDS

The relationship between the driving task and the visual roadway environment was examined through the determination of the driver visual information needs for positional, situational, and navigation tasks, including steering and speed control, car following, overtaking and passing situations, and direction finding. Field studies were then conducted to refine these needs and to determine the pattern and frequency of needs on various types of road facilities. The studies were conducted by teams consisting of four professionals and four lay drivers at eight sites, which included both controlled- and non-controlled-access facilities. The study technique used was diagnostic study combined with questionnaires and critique sessions. Conclusions reached during the critique sessions of the

study teams included: the most critical visual information needs are related to the necessity of maintaining positional information at all times, particularly information on lane lines, edge lines, and curb delineation; a view of the roadway surface is important at all times; some environmental lighting has a detrimental effect on performance of the driving task; and higher speeds and higher traffic volumes can produce definite visual task problems. On controlled-access facilities, roadway lighting systems should provide uniform lighting on pavement surface, infrequent spacings to reduce glare, median location to light areas adjacent to the roadway, high mounting heights to reduce glare, median location to reduce headlight glare, high-mast lighting in interchange areas, gradual transitions from light to dark areas, and gradual transitions from dark to light areas. On non-controlled-access facilities, roadway lighting systems should provide uniform lighting on pavement surface, infrequent spacings to reduce glare, high mounting heights to reduce glare, median location to reduce headlight glare, median location to light areas adjacent to the roadway, and gradual transitions from light to dark and from dark to light areas. The design procedure for effective roadway lighting must identify the informational needs of night drivers that are to be satisfied by roadway lighting, quantify the needs for warranting conditions and design guidelines, and provide a rational method for setting cost-effective priorities.

by Ned E. Walton  
Texas A and M Univ., Texas Transportation Inst.  
Publ: HS-017 795 (TRB-SR-156), Driver Visual Needs in Night Driving, Washington, D.C., 1975, p101-11  
1975 ; 27refs  
Presented at a symposium conducted at Ohio State Univ., 4-6 Sep 1974.  
Availability: In HS-017 795

HS-017 805

### IMPLEMENTING RESEARCH RESULTS

Recommendations regarding the implementation of roadway lighting research results are presented. As the hazards associated with glare may be expected to increase as the average age of the driver increases, and the payoff potential of reducing glare through the use of polarized headlighting is great, it is suggested that comprehensive research programs should be conducted to develop precise safety and public comfort benefits and cost penalty estimates so that a rational decision can be made on the implementation and configuration of polarized lighting systems. Implementation of automotive lighting systems research should include analysis of the cost-benefits, contribution to safety, lead time, and operational environment prior to standardization of new equipment, and should offer the equipment on an optional basis prior to making the item standard equipment. The need for more information, better measurements, and controlled studies on the relationship between accident rates and illumination in order to make more rational decisions with regard to the installation of roadway lighting systems is stressed. Improved or refined visibility criteria for certain night visual needs should be formulated. Highway illumination design standards should be developed which are based on performance specifications aimed at ensuring the driver at least a minimum level of visibility under all common roadway conditions rather than on hardware specifications.



by Charles A. Baker; Rex W. Oyler; Richard E. Stark; Richard N. Schwab  
National Hwy. Traffic Safety Administration; General Motors Corp., Anderson, Ind.; Illinois Dept. of Transportation; Federal Hwy. Administration  
Publ: HS-017 795 (TRB-SR-156), Driver Visual Needs in Night Driving, Washington, D.C., 1975, p12-9  
1975

Presented at a symposium conducted at Ohio State Univ., 4-6 Sep 1974.

Availability: In HS-017 795

HS-017 806

### **PARKING WITHOUT LIGHTS: THE EFFECT ON ACCIDENTS**

On April 30, 1972, new regulations in Great Britain came into force that allowed certain vehicles to park at night in specified circumstances without using lights. Under these regulations automobiles, bicycles, motorcycles, and delivery trucks (not exceeding 1500 kilograms unloaded weight) may park at night without lights, subject to the following rules: the road is subject to a 30 mile/hour or less speed limit; no part of the vehicle is within 15 yards of a road junction; and the vehicle is parked close to the curb and parallel to it, and (except in one-way streets) with its nearside to the curb. An assessment has been made of the effects of these regulations on accidents involving parked vehicles at night. The accident data was obtained from the computer records of the National Road Accident Report Form, and refer to 12 month periods before and after the regulations came into operation. The change in regulations was followed by an increase of about 36% (1100) in two-vehicle injury accidents involving parked vehicles in hours of darkness. Other types of accidents showed no change during the same hours. In the London area, where parking without lights was already widely permitted, but some further relaxation had been added, two-vehicle accidents in the dark involving parked vehicles showed a small, non-significant increase of eight percent.

by H. D. Johnson; C. G. E. Bryant  
Department of the Environment, Transport and Road Res. Lab., Crowthorne, Berks., England  
Rept. No. TRRL-Supp-77-UC ; 1974 ; 15p 3refs  
Appendix by C. G. E. Bryant.  
Availability: Corporate author

HS-017 807

### **PREPARATION AND OPERATION OF DIESEL ENGINES IN CONSTRUCTION AND INDUSTRIAL MACHINERY FOR OPERATION IN COLD CLIMATES**

Various papers and subjects that pertain to preparation of diesel engines for operation in cold weather are summarized. A unit that is prepared for colder weather must be able to handle warmer temperatures with a minimum of revision. The training of maintenance personnel is very important. Recommended maintenance should include: full fuel tanks to reduce condensation and drain sediment daily; the following of an oil schedule that maintains clean oil and a frequent oil level check; a daily check of the preheater fuel nozzles; and a weekly check of temperature controls, thermostats, space heaters, starters and electrical systems. Vehicles should be stored in protected locations. Continuous and intermittent

warm-up methods are described. In colder climates it is recommended that provisions be made for the largest practical battery and cable size. Electrical and pneumatic starters are discussed. Ether spray or a metered ether injection device can be used to insure reliable starting of diesel engines in cold weather. Antifreeze coolants are also discussed. The heating devices described are: immersion, tank type, electric, fuel fired, and fuel fired with recirculating pumps. Other topics covered are the intake system, lubricants, fuels, the air system, and engine compartment enclosures. There is an additional cost for equipment that works well in cold and arctic climates, but this is a small price to pay when compared to the losses in production time and labor costs that can result without these precautions. Drawings of various starting, heating, and cooling units are provided.

by W. G. Bugelski  
Cummins Engine Co.  
Rept. No. SAE-750473 ; 1975 ; 19p  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 808

### **PERFORMANCE OF ALUMINUM IN BIMETALLIC ASSEMBLIES**

Because of its light weight, aluminum is a prime candidate for automobile designers who are trying to make a lighter, fuel-conserving car without sacrificing automobile safety. The corrosion performance of aluminum alloys for automotive applications, when employed in bimetal assemblies, is discussed. The factors which most affect the degree of corrosion are: the type of metal, the anode-to-cathode area relationship, and the type of environment. It is possible to attach unprotected aluminum to unprotected steel in some parts of an automobile without fear of any galvanic corrosion. In areas that are exposed to chloride-containing road splash, damaging corrosion of unprotected aluminum could develop. One way to combat this problem is to use compatible parts such as galvanized steel, aluminized steel, or cadmium-plated steel for aluminum contact parts. Paint coatings, particularly those containing inhibitive pigments, can be put on steel and aluminum parts to combat the problem. Sealants, tapes, and gaskets can also be effective methods of minimizing or preventing galvanic corrosion. Galvanic corrosion can be dealt with effectively and economically.

by W. King; G. Sowinski; E. T. Englehart  
Alcoa Labs.  
Rept. No. SAE-750464 ; 1975 ; 11p 7refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 809

### **IMPROVED ASBESTOS MATRICES FOR ALKALINE FUEL CELLS**

One of the drawbacks in the use of the hydrogen-oxygen fuel cell is the corrosive effect that the potassium hydroxide (KOH) electrolyte has upon the interior of the cell. The purpose of this study was to determine how to increase the present operating temperature of this cell (less than 100°C) by increasing the corrosion resistance of matrix material. The

basic study of the KOH-asbestos reaction involved determinations of the nature of the reaction and of the effects of environmental parameters on the reaction. The parameters examined were: the KOH concentration (at 20, 40, and 60% levels); temperature (at 150°C and 200°C); and time (2 to 665 hours). The reactants were placed in bottles which were essentially inert in hot KOH up to 205°C. The precipitate that resulted from the reactions was dried at 120°C for 16 hours prior to weight analysis. Other tools used in evaluation of the corrosion reaction were x-ray diffraction and scanning electron microscopy. The corrosion of asbestos in hot KOH solution was demonstrated to occur by the leaching of silica from the asbestos, forming an insoluble magnesium hydroxide product and soluble potassium silicates. Experiments dealing with continuous exposure of asbestos to KOH revealed a slowing of the reaction with time, as the result of a silica build-up. By varying the parameters, morphologically different products could be obtained. The most promising approaches to achieving satisfactory matrix performance in a hydrogen-oxygen fuel cell are: the use of a highly converted (80 to 90%) asbestos which has the desired morphology; and the use of a potassium silicate additive to eliminate corrosion. These two ways of increasing the life of a fuel cell at higher temperatures should encourage the use of fuel cells as a type of energy converter in automobile equipment.

by W. B. Crandall; Y. Harada  
IIT Res. Inst.

Rept. No. SAE-750466 ; 1975 ; 7p 6refs

Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.

Availability: SAE

HS-017 810

#### A COMPUTER PROGRAM FOR CALCULATING PROPERTIES OF EQUILIBRIUM COMBUSTION PRODUCTS WITH SOME APPLICATIONS TO I.C. ENGINES

A computer model is presented which can, in some cases, be applied to internal combustion engines. This model is concerned with the gas phase products of the combustion of hydrocarbon fuels and air. The program rapidly calculates the equilibrium mole fractions and the partial derivatives of the mole fractions with respect to temperature, pressure, and the equivalence ratio for the products of combustion. A subroutine of this program calculates the gas constant, enthalpy, internal energy, and the partial derivatives of these with respect to temperature, pressure, and equivalence ratios. Some examples of calculations are included. Included in the appendices are: the curve fitting of equilibrium constants; mole fraction computation equations; partial derivative computation equations; and a guide to the use of certain subroutines.

by Cherian Olikara; Gary L. Borman  
University of Wisconsin

Rept. No. SAE-750468 ; 1975 ; 23p 16refs

Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.

Availability: SAE

HS-017 811

#### EFFECT OF ALCOHOLS AS SUPPLEMENTAL FUEL FOR TURBOCHARGED DIESEL ENGINES

The possibility of using alcohols as secondary fuels for diesel engines was investigated. Tests were run on an Oliver/Waukesha, open chambered 6-cylinder diesel engine. To take full advantage of charge cooling, alcohol was added at the turbocharger compressor inlet. Test instrumentation included: a smoke meter; an exhaust analyzer for use in detecting carbon monoxide and hydrocarbons; a nitrogen oxide analyzer; and a pressure transducer. Methanol, ethanol, and isopropanol were used in the tests. Engine loading rates were varied (full, 2/3, and 1/3 load at 1200 and 1800 rpm). Efficiency was not greatly affected by the addition of alcohol except under light load conditions. With a light load the efficiency decreased with increasing percentages of alcohol. Alcohol additions did not affect the gaseous emissions. Carbureting part of the fuel reduces smoke, thereby increasing the practical power/weight ratio. Turbocharger compression supplies the heat of vaporization necessary for good fuel distribution in intake systems not designed for liquid fuels. The resulting charge cooling benefits power output and engine life. Alcohols, particularly methanol, can serve as secondary fuels for small turbocharged diesel engines.

by K. D. Barnes; D. B. Kittelson; T. E. Murphy  
University of Minnesota

Rept. No. SAE-750469 ; 1975 ; 11p 8refs

Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.

Availability: SAE

HS-017 812

#### THE EFFECT OF LUBRICANT ADDITIVES ON THE DURABILITY OF PLATINUM OXIDISING CATALYSTS

A concern about the durability of platinum oxidizing catalytic exhaust convertors prompted research by a group in the British Technical Council of Motor and Petroleum Industries. Five reference oils (all low/30) were initially designed for rig, engine bench, and vehicle road tests. A test blend was adopted which was representative of a typical crankcase lubricant. The additive components were chosen to allow investigation of the effects of calcium, zinc, and of phosphorus from two different sources, zinc dialkyldithiophosphate (ZDDP) and an ashless anti-oxidant. The viscosity grading was selected to match the pattern of service station oils in the U.S. The engine bench tests were run using 4-cylinder overhead valve engines. They were cyclic tests of 100 hours duration. Two automobiles were used for the vehicle road tests (25,000 total miles at 32 mph average speed), one fitted with a 2 liter overhead camshaft engine and the other with a 1.5 liter engine with push rod operated overhead valves. Phosphorus arising from ZDDP or a combination of ZDDP and the ashless anti-oxidant is only mildly toxic. The phosphorus that originates from an ashless anti-oxidant can de-activate a platinum oxidizing catalyst, in the absence of calcium or zinc. In general, the presence of calcium or zinc appears to inhibit the poisoning effect of phosphorus on platinum oxidizing catalysts.

by W. Fitzgerald; J. V. D. Wilson  
Esso Chemical Ltd.; Edwin Cooper and Co., Ltd.

Rept. No. SAE-750447 ; 1975 ; 12p 10refs

Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975. Report of co-

operative work by an Investigation Group of the British Technical Council for the Motor and Petroleum Industries. Availability: SAE

HS-017 813

### FIELD SERVICE COMPATIBILITY OF ASHLESS AND FULLY COMPOUNDED ENGINE OILS WITH TWO BEAD-TYPE OXIDATION CATALYSTS

Eight catalytically equipped vehicles were used to compare the effects of an ashless, non-phosphorus lubricant and a conventional lubricant on the deterioration of two different types of bead catalysts operating in field service. Composite carbon monoxide (CO) emissions (measured by the 1975 Federal Test Procedure) nearly doubled during the 25,000-mile test with both oils relative to the fresh catalyst. No significant increase in composite hydrocarbon (HC) emissions was shown. There were no significant differences between the two oils with respect to either HC or CO emissions at the end of the test. Analysis of the aged catalyst showed average phosphorus contamination of 0.07 percentage of weight with the conventional oil compared to 0.01 percentage of weight with the ashless oil. The higher level of phosphorus contamination with the conventional oil was not accompanied by an increase in catalyst deterioration relative to the ashless oil.

by A. T. Meyers  
Chevron Res. Co., Richmond, Calif.  
Rept. No. SAE-750448 ; 1975 ; 12p 5refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 814

### THE ROLE OF LUBRICANT ADDITIVES IN CONTROLLING ABNORMAL COMBUSTION (ORI)

The effects of several lubricant-related variables on abnormal combustion are reviewed. The effects of basestocks, sulfated ash level, metal detergent type, and viscosity improvers were investigated. The data indicate that improved customer satisfaction can be achieved by design of lubricant type and additive components. Ashless or low sulfated ash oils and those formulated with hydrocarbon viscosity improvers are shown to contribute less toward octane requirement increase (ORI) and other types of abnormal combustion. The choice of metal detergent was also found to be important. The range of improvement can be as much as 4 octane units. An attempt is made to relate viscosity improver structure to stability and combustion chamber deposit forming tendency. The data demonstrate that careful selection of basestock, viscosity improver, and detergent system can result in significant reduction in ORI and improved overall efficiency. There is, however, still a need to develop a realistic and accurate test to predict ORI which can be used in the field.

by P. A. Barber; T. F. Lonstrub; N. Tunkel  
PARAMINS Technology Div., Linden, N. J.  
Rept. No. SAE-750449 ; 1975 ; 11p 9refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 815

### ENGINEERING THE THIRD GENERATION ECONOLINE

Techniques employed in the development of the 1975 Ford Econoline Van, Club Wagon, and Cutaway vehicles are described. The following specific engineering subjects are discussed: body-on-frame structural design applied to van, bus, and cutaway vehicles; development of an energy absorbing frame for these forward control trucks; engineering techniques applied to the resolution of vehicle shake problems; modifications to front and rear suspension for optimal ride, handling, and tire wear; development of integrated climate control systems for van and bus vehicles; and the engineering of derivatives for body builder recreation vehicle markets. Higher gross vehicle weights and higher vehicle payloads were made possible with a new body-on-frame construction which permits the use of a rubber body isolation system to reduce noise, vibration, and harshness levels in the vehicle. The development of an extended front end permits visibility of the front fenders from the driver's seat, improving vehicle maneuverability and parkability. Extensive testing at the Ford Arizona Proving Grounds verified that the 1975 Econoline has successfully met its product objectives. Numerous structure illustrations and performance curves are included.

by T. J. Walsh  
Ford Motor Co.  
Rept. No. SAE-750454 ; 1975 ; 44p  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 816

### MANUFACTURING THE THIRD GENERATION ECONOLINE

Highlights of the assembly operations for the 1975 model Ford Econoline III are described. A comparison of a few typical measures of complexity shows that the Econoline III has more than 3.5 times as many unique body models and almost twice as many sheet metal end items and spotwelds as the Econoline II. This greater product complexity, combined with a sourcing decision to perform more body subassembly operations in-house and an increase in the hourly production rate, plus the additional operations dictated by the separate body and frame design of the new Econoline, resulted in a substantial increase in the manufacturing floor space requirements. Econoline body and paint operations are performed at Ford's Ohio Truck Plant. Painted bodies are transported via special vans to the Lorain Assembly Plant for trim, frame, and final assembly operations. Photographs illustrating various stages in Econoline III assembly are provided.

by C. L. Knighton  
Ford Motor Co., Assembly Engineering  
Rept. No. SAE-750455 ; 1975 ; 19p  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 817

HS-017 817

### **WELDBOND AND ITS PERFORMANCE IN ALUMINUM AUTOMOTIVE BODY SHEET**

In weldbonding, a joint is produced by spotwelding through an uncured adhesive bondline or by flowing adhesive by capillary action into the bond area after spotwelding. An investigation undertaken to develop some of the fundamental information necessary to adopt the weldbond process to those industries using aluminum body sheet alloys is presented. Two aluminum alloys and body sheet steel were used to evaluate the weldbond process. The initial strengths and fatigue properties of spot-welded, adhesively bonded and weldbonded lap joints were compared. Axial load fatigue testing was conducted in a 5,000 pound fatigue machine at 18.3 Hertz. It was found that: aluminum body sheet alloys can be weldbonded using a variety of adhesives including vinyl plastisol and one and two part modified epoxy formulations; the initial strength of the weldbond joints may be higher, equal to, or lower than the strength of the corresponding adhesive joints, but are always higher than that for conventional spot weld joints; the weldbond joint durability in various environments was equal to that of the adhesive joint, but distinctly superior for vinyl plastisol points; the fatigue strengths of adhesive bonded joints and weldbonded joints were generally higher than for single spot welds; and the fatigue strength of weldbonded 0.040 inch aluminum joints was above that of the 0.032 inch steel spot welds when using either the polysulfide-epoxy or high peel strength epoxy adhesives.

by J. D. Minford; F. R. Hoch; E. M. Vader  
Aluminum Co. of America  
Rept. No. SAE-750462 ; 1975 ; 10p 9refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 818

### **TENSILE-SHEAR AND FATIGUE PROPERTIES OF RESISTANCE AND MIG SPOT WELDS OF SOME ALUMINUM AUTO BODY SHEET ALLOYS**

Fatigue is an important consideration in the design of many automotive parts and assemblies because of the fluctuating loads imposed on them. Tensile-shear static and fatigue tests were conducted on MIG (GMA) spot welds in various combinations of 2036-T4 and 5086-H32 aluminum sheets with thicknesses ranging from 0.035 inch (in) to 0.125 in. Both single-spot and double-spot coupons were welded for each alloy combination. Although the average weld diameter at interface did not vary much among the various alloy and thickness combinations, the static and fatigue strengths increased substantially as the overall thickness of the lap joints increased. Filler alloys 4043 and 5356 produced similar fatigue strengths. On a pound/spot basis, the single-spot coupons had slightly higher fatigue strengths than the double-spot ones. Tests were also conducted on resistance spot welds in combinations of 2036-T4, 5056-0, 5056-H111, and 5052-H32 sheet having thicknesses of 0.035 in and 0.050 in. With fatigue load expressed in pounds, the 0.035 in thick sheet welds had very similar fatigue curves. Their curve for the higher strength 5052 welds (0.050 in thick sheet) was substantially higher than for the thinner sheet. For the same sheet thickness and weld diameter, resistance spot welds gave slightly higher static strength than MIG welds. For 0.035 in thick 2036, the MIG spot welds had fatigue strengths, based on percent of static strength, similar to those of resistance welds.

HSL 76-05

by N. L. Person  
Kaiser Aluminum and Chemical Corp.  
Rept. No. SAE-750463 ; 1975 ; 14p 1ref  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 819

### **MAINTENANCE OF AUTOMOTIVE ENGINE COOLING SYSTEMS--HS40. 3RD ED.**

The description, function, and maintenance of typical automotive vehicle engine liquid-cooling systems are analyzed. The interrelation of the cooling system and other engine systems is discussed: the engine lubrication system; the fuel system; the ignition system; the exhaust system; automatic transmission systems; and the air conditioning system. All cooling system components are described, their functions are explained, and photographs are provided. General preventive maintenance procedures for the driver and the mechanic and troubleshooting procedures for correction of cooling system difficulties (overheating, overcooling, and internal leakage) are discussed.

Society of Automotive Engineers, Inc., 400 Commonwealth Dr., Warrendale, Pa. 15090  
1975 ; 31p  
SAE Information Rept. Handbook Supplement.  
Availability: SAE

HS-017 820

### **INTERSECTION CONFLICTS**

The conflict points at simple T-intersections, four-way, three-way, and multi-way intersections are enumerated, discussed, and illustrated. A general method of intersection conflict analysis is presented. Various applications of conflict analysis are discussed: practical applications; the comparison of priority rules; analyzing conflicts with various rules; analyzing the effects of regulatory signs; and analysis of major-minor and priority systems and channelization. The use of conflict analysis to determine intersection accident exposure and the effect of vehicle interactions are also considered.

by J. F. M. Bryant  
Australian Road Res. Board, 500 Burwood Hwy., Vermont South, Victoria (Bag 4) P.O. Box 156, Nunawading, 3131, Australia  
Rept. No. ARR-7 ; 1973 ; 54p 20refs  
Availability: Corporate author

HS-017 821

### **ALCOHOL IN RELATION TO ROAD SAFETY**

Past and current research into the subject of traffic safety and alcohol is reviewed. Rehabilitative, educational, and enforcement countermeasures to drinking and driving are discussed. Major conclusions of the review include: alcohol contributes to about 50% of all fatal traffic accidents in Australia and to a higher proportion of those occurring at night and on weekends; among detected drinking drivers there is a gross over-representation of males, blue-collar workers, and individuals with prior serious traffic convictions, repeated drink-driving offenses, criminal records, and blood alcohol concentrations (BACs) exceeding 0.10; responsible and excessive

drinkers can be defined in quantitative terms based on alcohol intake; less than 10% of males and a smaller proportion of females qualify as excessive drinkers; the drinking habits of detected drinking drivers bear close resemblance to those reported in the histories of alcoholics; and the choice of countermeasures to reduce drunken driving accidents depends largely on whether drinking driving is regarded as a traffic problem or as a community health problem.

by Anne Raymond  
Australian Rd. Res. Board, 500 Burwood Hwy., Vermont  
South, Victoria (Bag 4) P.O. Box 156, Nunawading, 3131,  
Australia  
Rept. No. ARR-2 ; 1974 ; 107p 356refs  
Availability: Corporate author

HS-017 822

### **BREATHALYSED DRIVERS--TO COURT OR CLINIC?**

Drinking drivers who are apprehended and breathalyzed by the police in Australia have been found to have, as a group, traffic conviction records which differ significantly from those of the driving population as a whole. Serious offences, such as dangerous driving, failing to stop after an accident, and driving while disqualified, are ten times as frequent among breathalyzed drivers as among those in the general population. High blood alcohol levels and repeated drunken-driving convictions strongly suggest that the drinking habits of the breathalyzed group are excessive when compared to those of the majority of the community. Personal interviews with breathalyzed drivers regarding their drinking habits tend to confirm that their drinking is excessive. The fact that a driver attracts police attention and is breathalyzed seems to be a fairly reliable warning signal that his drinking habits are likely to be excessive. This suggests that a group of persons whose drinking behavior identifies them as a high risk group for two major community health problems--accidents and alcoholism--are presently being dealt with simply as traffic offenders. About one-third of breathalyzed drivers are under 25 years of age. This suggests that an opportunity for therapeutic action exists, since they are at a relatively early stage of their drinking careers. However, the early warning signal given by a drunken-driving conviction is generally being ignored at present.

by Anne Raymond  
Australian Rd. Res. Board, 500 Burwood Hwy., Vermont  
South, Victoria, (Bag 4) P.O. Box 156, Nunawading, 3131,  
Australia  
Rept. No. ARR-18 ; 1975 ; 12p  
Availability: Corporate author

HS-017 823

### **POSSIBLE LOSS OF DIRECTIONAL CONTROL WHEN DRIVING ON SECTIONS OF SANDED, PRIMED SURFACE ON HIGHWAY CURVES**

Possible driver and vehicle behavior which may result when an abrupt change from a high friction sealed pavement to an adjacent section of primed and sanded surface occurs on a road curve was investigated. In particular, the possibility of the change in friction properties along the curve producing loss of directional control was examined. The following conclusions were reached: that it is most unlikely that the change in surface would directly result in skidding for a vehicle travelling at

the advisory speed; that an unlikely combination of circumstances would be required for the change in surface to directly cause skidding during constant speed cornering for vehicles travelling at the 85th percentile speed; that, for the 85th percentile speed, the friction available on a primed, sanded surface is sufficiently small for skidding to be readily induced by the application of a moderate amount of braking or excess tractive power; that the change in surface could sufficiently alter the vehicle trajectory for an inexperienced driver to respond to with an unnecessarily large and abrupt control movement, causing a skid; that the change in surface could cause the vehicle to drift off the paved surface if an appropriate corrective action were not applied promptly; and that the change in pavement surface along a curve must be regarded as creating a potential hazard which should be indicated by appropriate warning signs.

by J. R. McLean  
Australian Road Res. Board, 500 Burwood Hwy., Vermont  
South, Victoria (Bag 4) P.O. Box 156, Nunawading, 3131,  
Australia  
Rept. No. ARR-12 ; 1973 ; 54p 20refs  
Availability: Corporate author

HS-017 824

### **MOTORCYCLIST HELMET AND DAYTIME HEADLAMP USE LAWS: EFFECTS ON USE AND FATALITIES**

The effects of motorcyclist helmet and daytime headlamp use laws on motorcycle use and fatalities were investigated. Observations of motorcycle riders in states with and without mandatory helmet use laws showed that virtually all of the riders in Georgia and Maryland, where helmet use is required, were using helmets; while in the absence of laws requiring helmet use, more than 60% of California riders were using helmets, but only 25% of Illinois riders were using them. In Georgia and Illinois, where mandatory daytime headlamp use laws are in effect, 87% and 98% (respectively) of the motorcycles had their headlamps on. In the two states without headlamp use laws, 51% of those observed in California were using lamps and 43% of those in Maryland had their headlamps on. Analysis of the data on the average fatal motorcycle crash involvement rates per 10,000 registered motorcycles before, during and after the years of enactments of helmet use laws shows that, while the average fatal involvement rates were the same for states enacting laws and their matched states not enacting laws before the enactment of helmet use laws, the rate declined by about 30% in those states enacting laws, both in the years of enactment and in the following years, while the rate remained the same in states not enacting helmet use laws. In the year following the enactment of daytime headlamp use laws, the proportion of fatal crashes involving motorcycles decreased from that of the prior year in each of the states enacting such laws relative to the total such fatalities in it and its comparison state not passing such laws. It is concluded that motorcyclist helmet use laws represent social policy that has been effective in achieving the purpose of reducing fatal injuries. Headlamp use laws may achieve the same purpose, but data on more states will be necessary before a more definite conclusion with respect to the value of daytime headlamp use can be reached.

by Leon S. Robertson  
Insurance Inst. for Hwy. Safety, Watergate 600, Washington,  
D.C. 20037  
1975 ; 20p 18refs  
Availability: Corporate author

HS-017 825

HSL 76-05

HS-017 825

# **A GUIDE TO UNDERLOAD VEHICLE TESTING**

Various aspects of vehicle underload dynamometer testing are discussed. The operation of a dynamometer is described and the advantages of underload testing are considered. The use of the dynamometer and its instrumentation in vehicle performance measurement and the fundamental operations of the internal combustion engine are analyzed. Dynamometer underload testing of compression (rings, valves, and gaskets), carburetion (fuel and air supply systems); ignition (electrical and mechanical systems), chassis (transmissions and drivelines), and brakes is also discussed. A method of organizing the use of a dynamometer is suggested.

Clayton Mfg. Co., Educational Dept., El Monte, Calif.  
Rept. No. C-1575.2 ; 1975 ; 110p  
Supersedes HS-009 083 dated 1969.  
Availability: Corporate author, \$5.00

HS-017 826

# **NATIONAL TRANSPORTATION REPORT. CURRENT PERFORMANCE AND FUTURE PROSPECTS. 1974**

The state of the United States (U.S.) transportation system in 1974 is reported and alternatives for improving transportation performance in the future are discussed. Information on plans and priorities for state and local transportation systems (urban, intercity, and rural) is included. Highway, rail, air, water, and pipeline transportation plans and alternatives are examined. The national issues affecting U.S. plans and programs are considered: the effects of higher energy prices on transportation, and financial and institutional issues. Governor's summaries from various states on transportation policies and plans as well as major conclusions regarding the conduct of and findings from the National Transportation Survey of 1974 are provided. Transportation cost, mileage, usage, speed, revenue, emission, accident, fatality, and related data are also included.

Department of Transportation, Washington, D.C.  
1975 ; 699p refs  
Availability: GPO, \$7.50, stock no. 050-000-00105-9

HS-017 827

# **FACTORS INFLUENCING THE HOT FUEL VAPOUR HANDLING CHARACTERISTICS OF GASOLINE ENGINED AUTOMOBILES**

Fuel and engine design features associated with the hot fuel handling performance of European cars are discussed and suggestions on test locations and procedures are included. Vehicle design features affecting hot fuel handling performance have changed significantly in recent years resulting in the need to improve vapor tolerance. Vehicle design features conducive to good hot fuel handling performance (fuel tank, fuel pump, carburetor/fuel injection system, fuel lines, and fuel filters) are discussed, with particular emphasis given to the design of mechanical fuel pumps, the component from which further development would bring most benefits. A wide variety of mechanical fuel pumps (short lever, long lever, and push-rod actuated) has been rig tested to determine the time taken to deliver a quantity of reference fuel against a range of fuel-pump body temperatures for a camshaft speed of about 1500 rpms. The effects of static delivery pressure and diaphragm

stroke are considered and further development of the test rig is described (fuel pump design, valves, diaphragm, static delivery pressure, priming, actuating mechanism, and fuel recirculation). Photographs of the fuel pump test rig assembly and some of the fuel pumps tests are provided. The need is emphasized for still closer cooperation between the oil and motor industries in the future to achieve optimum use of natural resources and provide maximum vehicle user benefit.

by F. H. Palmer

Publ: Institution of Mechanical Engineers, Proceedings, London, 1975, v189 p1-12  
1975 ; 13p 21refs

Prepared for presentation at an Ordinary Meeting of the Institution of Mechanical Engineers, Birmingham Airport, England, 20 May 1975.

Availability: Institution of Mechanical Engineers, 1 Birdcage Walk, London, SW1H 9JJ, England

HS-017 828

# **EXPERIMENTAL AND THEORETICAL PERFORMANCE OF A RADIAL FLOW TURBOCHARGER COMPRESSOR WITH INLET PREWHIRL**

A preliminary theoretical and experimental study has been conducted on the performance of a turbocharger centrifugal compressor with inlet prewhirl. The experimental results have shown that stable operation can be extended to low flow rates by the introduction of positive prewhirl. These techniques are now to be applied to turbocharged diesel engines to improve their flexibility. While the initial theoretical study showed that forced vortex prewhirl yielded the most favorable inducer incidence variation with radius, for practical reasons the experimental study was confined to simple straight line vanes yielding a constant whirl angle with radius. The free vortex prewhirl yielded the most undesirable inducer characteristics. These preliminary studies, however, were conducted with the assumption that the impeller inducer be composed of radial blade fibers. By adopting an inducer with non-radial blade fibers, it should be possible to accept free vortex prewhirl without incidence loss. It has been suggested that significant changes in the surge characteristics could be achieved with prewhirl if the vaneless diffuser is not operated close to the stalling limit. Modification of the diffuser design may, therefore, lead to further improvement in the surge margin. The full benefits of inducer prewhirl may only be achieved if the initial compressor design was specially performed with a view to accommodating prewhirl. This would involve, particularly, inducer design, to minimize incidence loss, and vaneless diffuser design, to maximize the stable operating range.

by F. J. Wallace; A. Whitfield; R. C. Atkey

University of Bath, Claverton Down, Bath, England  
Publ: Institution of Mechanical Engineers, Proceedings, London, 1975, v189 n43 p177-86  
Rept. No. 43/75 ; 1975 ; 11p 16refs

Availability: Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1H 9JJ, England

HS-017 829

# **THE USE OF ACCIDENT DATA IN STUDYING VEHICLE HANDLING PERFORMANCE**

A study to establish the relation between vehicle handling and accident causes is reported. Since deficiencies in handling are

likely to be associated with accidents involving loss of control, measures of handling which are likely to express proneness to loss of control are first suggested. Emphasis is placed on simplicity of measurement in order to allow as many different models of car as possible to be included in the study. Accident rates for the various accident types which are likely to be influenced by these parameters are then determined by model of car. The effect of other factors, such as variation in driver characteristics between different car models of car, on these rates, is then assessed so that the relationship between handling characteristics and accident frequency can be defined. Finally, the relative importance of the various measures of vehicle handling performance, such as steady state response, transient response, subjective assessment of handling, and braking characteristics, are assessed. The results of this investigation suggest that there is a definite relation between handling performance and accident causation, although it is relatively small when compared to the effects of driver characteristics such as age and sex. In explaining the variation in the accident rate between different models of cars, driver characteristics account for as much as 70%; if driver effects are removed from the accident rate, then handling parameters explain between 35% and 40% of the remaining variation between models of cars. The important parameters appear to be weight, a measure of the change in understeer as a function of lateral acceleration, and power to weight ratio. The results of analyses of fatal and serious injury single vehicle and car to car accidents are tabulated by car model and driver age.

by I. S. Jones  
Calspan Corp., Transportation Safety Dept., P.O. Box 235,  
Buffalo, N.Y. 14221  
Publ: Institution of Mechanical Engineers, Proceedings,  
London, 1975, v189 n39 p243-58  
Rept. No. 39/75 ; 1975 ; 17p 21refs  
Prepared for presentation at an Ordinary Meeting of the  
Automobile Division, Dunstable, Beds., England, 23 Sep 1975.  
Availability: Institution of Mechanical Engineers, 1 Birdcage  
Walk, London SW1H 9JJ, England

HS-017 830

# **COMBUSTION, KNOCK AND EMISSION CHARACTERISTICS OF A NATURAL GAS FUELLED SPARK IGNITION ENGINE WITH PARTICULAR REFERENCE TO LOW INTAKE TEMPERATURE CONDITIONS**

With various fuel-air mixtures and different compression ratios, the intake temperature was varied over the entire range of 200°F down to -100°F for a single-cylinder spark ignited research engine fuelled with natural gas. Performance data--including knock and ignition limits, the nature and extent of exhaust emission, and chamber pressure cyclic variation--were obtained. These data were then interpreted in terms of engine operation on liquefied natural gas (LNG). This experimental work confirmed in general the attractive features of the use of natural gas as a fuel in a spark ignition engine operated under extremely cold intake temperature conditions and that emissions of pollutants were not significantly increased. As the intake mixture temperature is lowered, there can be an increase in the mass of the inducted mixture and the mean peak cylinder pressure, which can lead to a possible increase in the indicated power developed by the engine. Although the engine is effectively supercharged, the onset of knock, which occurs with mechanical supercharging, is discouraged. The price for these gains seems to be a slight decrease in the fuel lean ignition limits--measured as air-fuel ratios--as the intake mixture

temperature is lowered. However, due to a concurrent decrease in the onset of knock limits, the range of air-fuel ratios for knock free operations appeared virtually unaffected.

by G. A. Karim; I. A. Ali  
University of Calgary, Calgary, Canada; Kwara State Coll.,  
Ilosia, Nigeria  
Publ: Institution of Mechanical Engineers, Proceedings,  
London, 1975, v189 n24 p139-47  
Rept. No. 24/75 ; 1975 ; 10p 24refs  
Availability: Institution of Mechanical Engineers, 1 Birdcage  
Walk, London SW1H 9JJ, England

HS-017 831

# **SOME EXPERIENCES OF FUEL DILUTION OF LUBRICATING OILS IN SMALL DIESEL ENGINES**

Fuel dilution of lubricating oils in small diesel engines is normally attributed to fuel leaking past seals, pumping elements, or feed pump diaphragms. Some authorities view dilution greater than 10 to 15% as inadvisable; others advocate an oil change if the viscosity is more than an S.A.E. grade. Other possible causes of dilution depend on fuel properties, nozzle design, and aspects of air flow into a cylinder. The fuel introduced in this manner plays some part in the combustion process and influences engine smoke levels. The dilution so caused is speed and temperature dependent. Analysis of this last cause of oil dilution shows that fuel, nominally contained in a nozzle sac between injections, is 'blown out' by the air flow when the inlet valve of an engine opens. This fuel is deposited on the cylinder head and passes to the cylinder walls, where it is either acted on or plays some part in the combustion process. When this quantity of fuel is sufficiently large, some of the fuel fractions are transferred by piston ring action, thus adding to the lubricating oil content in the crankcase. Engine load, temperature, speed, and fuel type influence this process. Reducing the sac volume has been effective in reducing or practically eliminating fuel oil dilution of lubricating oil, which principally occurs at low engine loads. Other means appear possible, such as a suitably positioned masked inlet valve to reduce fuel oil dilution from this cause. Fuel that is diluting lubricating oil in this way will only evaporate at a low rate from an engine sump, and this is dependent on the nature of the fuel. A fuel with higher boiling point constituents will provide larger additions to the lubricating oil and will persist for a longer period when dilution occurs. Engine tests (40 hour runs with oil samplings every 5 hours), techniques of combustion flame photography using a ported two-stroke engine, rig tests with a stripped fuel injector, and confirmatory engine tests with modified fuel injector nozzles are all briefly described.

by J. C. P. Thornber  
Perkins Engines Co.  
Publ: Institution of Mechanical Engineers, Proceedings,  
London, 1975, v189 n20 p159-65  
Rept. No. 20/75 ; 1975 ; 8p 4refs  
Availability: Institution of Mechanical Engineers, 1 Birdcage  
Walk, London SW1H 9JJ, England

HS-017 832

# **PERFORMANCE PREDICTION FOR AUTOMOTIVE TURBOCHARGER COMPRESSORS**

A procedure to predict the complete performance map of turbocharger centrifugal compressors is presented. This is based



on a one-dimensional flow analysis using existing published loss correlations that were available and thermodynamic models to describe the incidence loss and slip factor variation at flow rates which differ from the design point. To predict the losses within the complete compressor stage using a one-dimensional flow procedure, it is necessary to introduce a number of empirical parameters. The uncertainty associated with these empirical parameters is assessed by studying the effect of varying them upon the individual losses and upon the overall predicted performance. The most difficult and critical parameter to be estimated is the overall diffusion ratio of the impeller. This controls the extent of the through-flow jet and in turn the predicted slip factor and mixing loss.

by A. Whitfield; F. J. Wallace  
University of Bath, School of Engineering, Claverton Down,  
Bath BA2 7AY England  
Publ: Institution of Mechanical Engineers, Proceedings,  
London, 1975, v189 n12 p59-67  
Rept. No. 12/75 ; 1975 ; 10p 14refs  
Availability: Institution of Mechanical Engineers, 1 Birdcage  
Walk, London SW1H 9JJ, England

HS-017 833

#### **SIMULATION MODEL FOR A CRANKCASE-COMPRESSION TWO-STROKE SPARK-IGNITION ENGINE INCLUDING INTAKE AND EXHAUST SYSTEMS**

A model is presented to simulate the power cycle and gas exchange process in a crankcase-compression, two-stroke spark ignition engine which includes intake and exhaust systems. Chemical equilibrium and a two-zone combustion model with a spherical flame front are assumed for the power cycle and generalized non-steady gas dynamic expressions, including variable composition, variable specific heats, friction, and heat transfer, are assumed for the gas exchange process in the intake and exhaust systems. For the scavenge process in the cylinder, a thermal mixing model is used to calculate the pressure changes. Experiments with a small high speed engine (a Rockwell JLO engine) showed that the model gave good predictions of the pressure changes during the gas exchange process and the air flow rate. The power predictions followed the experimental trend, but the quantitative results were not so good as the air flow predictions. Despite the limitations of the power predictions, the method offers the designer a tool for improving the performance of the crankcase-compression engine.

by R. S. Benson; P. C. Baruah; B. Whelan  
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Sackville St., Manchester M60 1QD England  
Publ: Institution of Mechanical Engineers, Proceedings,  
London, 1975, v189 n7 p167-75  
Rept. No. 7/75 ; 1975 ; 10p 13refs  
Availability: Institution of Mechanical Engineers, 1 Birdcage  
Walk, London SW1H 9JJ, England

HS-017 834

#### **SAFETY MOTORCYCLE**

To discover what happens to a motorcycle in a variety of collisions, a model about 24 inches long was constructed and fitted with a dummy figure; all were contained in a travelling cage moving down a sloping runway. The dimensions, velocities, and other properties of the components were related by the

principle of dimensional similarity so that the relative motions and velocities remained those of a full-sized machine. This enables the ultimate effect on the dummy to be photographed after the accident. From this a design for a safety motorcycle can be created that will withstand the collisions met in practice. Simulation tests of the following types of accidents involving motorcycles were conducted using the model: front impact against a rigid obstacle; skid on clear road and fall; side impact; roll-over; and rear impact on the stationary vehicle of a moving body or missile. The design arising from the conclusions reached in these tests would embody the following features: side guards and framing; hip belt; chest buffer; seat back for the front; side pillars, rear support, and back rest for the back seat; hand-operated stand; and safety helmets. This design is considered the minimum for reasonable safety at speeds up to about 30 mph and for reducing injuries at higher speeds. Detailed descriptions and photographs of test runs are appended.

by J. S. Westcott  
Publ: Institution of Mechanical Engineers, Proceedings,  
London, 1975, v189 n1 p1-16  
Rept. No. 1/75 ; 1975 ; 17p 5refs  
Prepared for presentation at an Ordinary Meeting of the  
Automobile Div. at Loughborough Univ., 18 Feb 1975.  
Availability: Institution of Mechanical Engineers, 1 Birdcage  
Walk, London SW1H 9JJ, England

HS-017 835

#### **GOVERNMENT'S BRIEF ON THE UNIFORM TIRE QUALITY GRADING STANDARDS**

A brief is presented of the Department of Transportation's response to petitions of the Uniroyal and B. F. Goodrich tire companies regarding the Federal regulation which sets forth uniform tire quality grading standards (UTQGS), issued in accordance with the mandate of the 1966 Federal Traffic and Motor Vehicle Safety Act. Tires have been marketed using confusing and misleading nomenclature. The qualities that are important to the consumer are treadwear, traction, and temperature resistance. This regulation seeks to provide the consumer with this information. Petitioners attack the Department for abandoning its earlier control tire approach. No bids for the production of a control tire were submitted by the closing bid date. Petitioners further attack the UTQGS because it fails to meet the need for motor vehicle safety and does not explain the properties that will be graded. The National Highway Traffic Safety Administration explains why these complaints are unjustified. Included in the presentation are: the history of the regulation; the efforts of the Administrative Procedure Act in promulgating the standard; the criteria applicable to the promulgation; and the rule's three grading tests, labeling, and leadtime requirements. The traction, treadwear, and temperature resistance tests are described. The rule's labeling requirements are reasonably calculated to meet the Act's purpose of informing the consumer. The leadtime allowed for implementation is argued to be quite adequate.

by Frank A. Berndt; Allan J. Kam; Rex. E. Lee; Ronald R. Glancz; Richard A. Olderman  
National Hwy. Traffic Safety Administration, Washington,  
D.C. 20590; Department of Justice, Civil Div., Washington,  
D.C. 20530  
Rept. No. 75-1568, 75-1785 ; 1975 ; 110p refs  
Availability: Technical reference library



HS-017 836

**VEHICLE LIMITS FOR ROAD SAFETY AND ROAD PROTECTION**

The need to place legal limitations on the size and mass of motor vehicles is explained. Restrictions on the mass of vehicles, axle loads, tire pressure, and overall dimensions are applied in all developed industrial countries in order to keep the cost of constructing and maintaining roads within reasonable bounds. Limitations imposed in the various States and Australian government territories on the maximum mass and dimension of registered road vehicles are reviewed and explained. Limits on maximum mass are usually governed by the vehicle design rules adopted by the Australian Transport Advisory Council and applied universally in the Australian States. The limit on tire pressure is intended to limit the damage caused by vehicles to the road and to safeguard the driver and other road users from the dangers of a vehicle loaded beyond the capacity of its braking system. The principal statutory dimensional limitations apply to width, height, overall length, rear overhang, and axle spacing. The present statutory limits are designed to enable roads to provide a reasonable level of service for their design life. A permit system allows a hauler to obtain a permit for the transport of exceptionally large or heavy loads under special conditions. The road standards selected for a particular route are primarily questions of economics. The National Association of Australian State Road Authorities has initiated a study to determine the most appropriate legal limits for road vehicles which could be applied nationally or in particular regions.

National Assoc. of Australian State Road Authorities, Sydney 1974 ; 20p  
Availability: Corporate author

HS-017 837

**POST-COLLISION VEHICLE FIRES. PROJECT REPORT**

Post-crash vehicle fires are examined. Literature available on post-crash fires includes several studies of the types of accidents in which burn injuries are most likely to occur, fuel system design factors which are relevant to fires in traffic accidents, and surveys of the types of accidents in which post-collision vehicle fires occur conducted in several states and countries. A study of the rate of incidence of fuel leakage and vehicle fires was conducted in Birmingham, England. A study of the Fire Brigade records of cases in which fuel was washed from the roadway following a collision or in which vehicle fires were attended and of city police records of vehicle accidents indicated that: 7.4% of all vehicle fires were associated with collisions; 0.29% of all vehicle collisions resulted in vehicle fires; and 1.3% of all vehicle collisions caused fuel leakages. It is suggested that these figures represent the absolute minimums, since many small volume leakages are not reported. Members of the Accident Research Unit at Birmingham University analyzed post collision fire cases. The accidents investigated were drawn from reports on high energy impacts in current production cars. Of the over 1,150 accident files studied, only 33 vehicles sustained post crash fires. Of the 60 people involved, 21 were fatally injured, 16 of which were burned to death in the post-impact fire. Post-mortem investigations indicated that in 75% of these 16 cases, no life threatening injuries resulted from impact forces. In addition, seven persons received burns, and two of these people died.

Analysis of accident damage to the vehicles indicated that 24% of the vehicles in which post-impact fires occurred rolled over during the accident. In all but one of the cases involving rollover and post-impact fire, the vehicle came to rest inverted, and in those cases in which an occupant burned to death, 42% of the vehicles came to rest inverted. In 27 cases, the passenger compartment was significantly involved in the post crash fire. Identified fuel leakages occurred in the fuel filler cap area in over 50% of the leakage cases. An extensive bibliography is included.

by P. F. Gloyns; G. M. Mackay; S. Chatterjee  
University of Birmingham, Accident Res. Unit, England  
1975 ; 26p 44refs  
Availability: Corporate author

HS-017 838

**MEASURING THE PHYSICAL DIMENSIONS OF U.S. INFANTS AND CHILDREN**

In March 1975, a multidisciplinary research team at The University of Michigan completed a three year study designed to obtain 41 different anthropometric measurements on 4,000 infants and children representative of the U.S. population. The children ranged in age from 2 weeks to 13 years. The principal purpose of the study was to obtain data essential for the development of improved standards for the safe design of toys, furniture, bicycles, automotive child restraint seats, and other products used for or by infants and children. Two field teams using specially modified measuring devices linked to a portable NOVA 1220 minicomputer measured subjects at 76 locations in eight states in accordance with a sampling plan based upon U.S. Census and Department of Health, Education, and Welfare population data. The 41 dimensions measured consisted of: five general body measures; five body segment lengths; 11 hand, foot, and finger measurements; five body segment breadths; four body segment depths; nine segment circumferences; and standing and sitting center of gravity. The study results for each measurement present the sample size, the mean, the standard deviation, and the 5th, 50th, and 95th percentile numbers for 22 age intervals.

by Richard G. Snyder; Martha L. Spencer; Clyde L. Owings; Lawrence W. Schneider  
Publ: HIT Lab Reports v6 n1 p1-23 (Oct 1975)  
1975 ; 24p refs  
Availability: See publication

HS-017 839

**TRUCKS: AN ANALYSIS OF ACCIDENT CHARACTERISTICS BY VEHICLE WEIGHT**

To obtain better information on which to base procedures for licensing operators of large trucks, an analysis was performed of a year's sample (1973) of truck crashes (253,459 in all) reported in North Carolina. Trucks were divided into the following three groups: large trucks, including three-axle trucks and tractor-trailers; intermediate trucks, including two-axle trucks more than 24,000 lbs Gross Vehicle Weight (GVW); and small trucks, including two axle trucks weighing 24,000 lbs GVW or less. Larger trucks were found to be more likely to be involved in single vehicle crashes than cars or smaller trucks, and in such accidents the truck drivers are just as likely to be killed as car drivers. Large truck crashes are hardly ever related to the truck driver's use of alcohol or to other physical

conditions. When a car collides with a truck, the car driver nearly always sustains a more serious injury than the truck driver, and a large proportion of such accidents involve fatalities. Truck drivers appear to encounter difficulties in getting their vehicles stopped, whether because of brake failure or insufficient braking power, and trucks in crashes are more likely than cars to be reported as having vehicle defects. Although drivers of large trucks generally are less likely to be found in violation than car drivers, the truck operator is more likely to be found in violation in multi-vehicle accidents. Generally, small trucks appear much like cars on the basis of accident report information, while the two-axle trucks over 24,000 lbs GVW appear more like the large trucks. Tables are given for each vehicle class in relation to accident types, vehicle maneuvers, accident characteristics, month, day, and hour of accident, light, weather, and pavement conditions, accident locations, defects, vehicle speeds, driver characteristics, seat belt usage, violations, and accident and injury severity.

by Lorraine S. de Savornin Lohman; Patricia F. Waller  
University of North Carolina Hwy. Safety Res. Center, Chapel Hill, N. C.  
1975 ; 75p 5refs  
Supported in part by the North Carolina Governor's Hwy. Safety Prog.  
Availability: Corporate author

HS-017 840

### VERTEBRAL COLUMN INJURIES AND SEAT BELTS

Seven automobile accidents in which 11 occupants received vertebral column fractures are examined to investigate the relationship between such injuries and seat belt use. The most common lumbar fracture is the simple compression fracture at the thoracolumbar junction produced by a combination of vertical load and hyperflexion. This type of injury is not typical of seat belt related fractures, which are generally a distraction type injury with separation of the spine and posterior elements from the adjacent vertebra. Compression and flexion fractures in car crash victims are found to be not related to the use of lap belts, but rather to be due to the vertical forces imposed on the lumbar spine. The cases reviewed show that similar--if not identical--lumbar vertebral injuries can occur in car occupants wearing or not wearing lap belts at the time of the crash. Causally relating a lumbar injury to the lap seat belt is therefore in error. Only distraction injuries located between lumbar vertebrae 2 and 4 with no evidence of either compression or anterior wedging can be causally related to a lap belt. Even some injuries with this type of configuration have been observed in persons who were not wearing seat belts. The type and location of the lumbar spine injury can frequently be an indicator of load application. Other body injuries, or the lack of them, are often good clues to determine the point of load application causing lumbar injury. It has been recommended that additional details of the injuries and of the accident be obtained for accuracy in the reporting of seat belt injuries. X-ray photographs of lumbar injury and photographs of the automobile crash damages are provided.

by Donald F. Huelke; Herbert Kaufer  
Publ: Journal of Trauma v15 n4 p304-18 (Apr 1975)  
1975 ; 72refs  
Availability: See publication

HS-017 841

### ROAD SAFETY OF CHILDREN IN THE UNITED KINGDOM

Methods for improving the road safety of children between the ages of 5 and 9 in England were investigated. About 90% of the road accidents resulting in death or injury to these younger school age children occur when the children are crossing the road or bicycling. Activities aimed at reducing the numbers of such accidents to children include: road safety education programs in schools; training programs; propaganda; and the provision of pedestrian crossing facilities. A survey of 1,277 primary schools and 936 secondary schools showed that the poster is the main teaching aid used in road safety instruction programs in the schools. Only 35% of primary schools and 17% of secondary schools had a planned program of road safety teaching. However, only 16% of primary schools and 4% of secondary schools had time set aside for road safety programs. Most head teachers felt that parents should have the primary responsibility for road safety training. A pedestrian crossing code appropriate for teaching to young children was developed by the Transport and Road Research Laboratory of the British Department of the Environment. Both the Royal Society for the Prevention of Accidents and the police provide materials and programs for teaching road safety.

by K. Russam  
Transport and Road Res. Lab., Rd. User Characteristics Div., Crowthorne, Berks., England  
Rept. No. TRRL-LR-678 ; 1975 ; 16p 6refs  
Availability: Corporate author

HS-017 842

### AN ANALYSIS OF SOME WORLD TRANSPORT STATISTICS

An overview of trends in world passenger and goods transport by mechanical means since 1950 is presented. Passenger transport by road, train, air, and sea during the period from 1950 to 1970 is examined, and estimates of the passenger kilometers (km) and ton-kilometers transported by each method in different areas of the world are presented. Dramatic increases have occurred in passenger transport during this period, and passenger kms per person have increased from 1,400 per year to 3,000 per year. There are still marked disparities in passenger travel between regions, varying of an average per person travel distance of 10,000 kms per year in North America to about 1,000 kms per person per year in Asia and Africa. Goods transport by all modes has increased rapidly during this period. Shipping accounted for over 50% of all the ton-kms of goods transported in 1950 and for about 70% of all ton-kms of goods transported in 1970. Goods transport by air increased about 17-fold during this period, although it still accounts for only 0.1% of the total ton-kms moved by all modes. While the share of rail transport has decreased substantially, the amount of freight shipped by rail has increased steadily. Predictions of future trends in passenger and goods transport suggest that: passenger transport by road, rail, and air will continue to increase during the next 20 years, with transport by air increasing the most rapidly; transport of goods by road is expected to double during this period; transport of goods by rail is expected to increase only slightly, with its share of the total continuing to decrease; and transport of goods by air is expected to increase 10-fold, significantly increasing its share of the total ton-kms transported.

May 31, 1976

HS-017 845

by A. H. Tulpule  
Transport and Road Res. Lab., Urban Transport Div.,  
Crowthorne, Berks., England  
Rept. No. TRRL-LR-622 ; 1974 ; 52p 20refs  
Availability: Corporate author

HS-017 843

### **INJURY NUMBERS FOR VARIOUS FRONTAL CRASH TESTS**

A series of crash tests was conducted on General Motors vehicles in the Opel line in order to evaluate the difference in results obtained by proposed alternative methods of investigating crash worthiness and occupant protection in 30 mph frontal impact accidents. The comparison was made on the following commonly used criteria: Severity Index (SI) and Head Injury Criteria (HIC-I) numbers; vehicle deceleration; seat belt loads; and femur loads. The dummy used for the rating was a General Motors Hybrid II, 50% percentile. In all tests standard static 3-point-safety belts without inertia reels were used. Results of the various tests indicate that regardless of the kind of frontal impact tests used, head and chest decelerations start at about the same time after impact and that the peak values occur at the same time. When the deceleration traces were calculated into injury numbers, the values for head HIC and chest SI were lower for a 30° impact and lower yet for a one-half offset barrier test. Although the test results do not show a good correlation of average deceleration and injury numbers, there is a good correlation consistent with these models between the permanent maximum crush and the injury numbers. It is concluded that for the models tested the modification of the flat frontal barrier test into a 30° or one-half offset test would result in: somewhat higher steering wheel intrusion; somewhat higher load into the doors; and minimal larger toe pan deformation. These results indicate the need for a more severe test of the body structure. However, the modification of the tests would also result in lower injury numbers for the occupants. These results are valid as long as passenger compartment deformation or intrusion is not a significant factor.

by E. S. Kiefer  
(Adam Opel AG) General Motors Overseas Operations, D-609,  
Postfach, Federal Republic of Germany, Ruesselsheim,  
Germany  
1975 ; 21p  
Presented at the Seminar for Accident Research, Univ. of  
Cologne, 4 Oct 1975.  
Availability: Corporate author

HS-017 844

### **A STATISTICAL PROFILE OF MOTOR VEHICLE OPERATORS WHO HAVE COMPLETED THE STATE OF CONNECTICUT DRIVING WHILE INTOXICATED REEDUCATION PROGRAM**

A statistical profile of motor vehicle operators who have completed the State of Connecticut Driving While Intoxicated Reeduction Program is presented. A sample of 2,000 first offender drivers was used for the purposes of this survey. Of these drivers, 1,840 were male and 135 were female. The average age for males was found to be 37.8 years, while that for females was 41.2 years. The average number of years of schooling completed by males was 11.5, compared to 11.8 for females. The weekly income levels for males were found to be significantly higher than those for females, although the unem-

ployment rate was almost the same for both groups. A greater incidence of divorce was found among the women in the program than among the men, and females also experienced a greater incidence of loss of spouse. The average family size for male participants was found to be above that for females. The number of children was more uniformly distributed for males than for females. Data indicated that a male was more likely to have had a previous arrest than a female, and that the mean age at the time of the first arrest was 29.7 for males and 37.0 for females. Females began drinking significantly later in life than males, and the frequency of drinking on the part of males was significantly above that of females.

by Frank C. Grella; Michael J. Panik  
1975 ; 55p 7refs

Prepared for the State of Connecticut Dept. of Motor Vehicles. Cover title: The Drinking Driver; a Statistical Profile of First Offender Alcohol Involved Drivers in Connecticut. Availability: State of Connecticut Dept. of Motor Vehicles

HS-017 845

### **AUTOMOBILE TIRE NOISE: RESULTS OF A PILOT STUDY AND REVIEW OF THE OPEN LITERATURE. FINAL REPORT**

Automobile tires contribute significantly to noise in the environment, due to the large number of cars in operation. A pilot study was designed to investigate the influence of the following parameters on automobile tire noise levels: tire inflation levels; tire loads; speed; tread design; tire wear; and pavement surface. The test vehicle used in this program was a 1973 Plymouth Fury. The vehicle was equipped with a V-8 engine (318 cubic inches) and an automatic transmission. The car was operated in a loaded condition. Two microphones were located at 25 and 50 feet from the centerline of the lane in which the vehicle travelled, along a line perpendicular to the path of travel. Radio transmitters were activated by the car running over a tape switch located along the test lane parallel to the path of the vehicle. Coaxial cables connected the microphones with the tape recording and monitoring equipment. The National Bureau of Standards analyzed the tapes. Vehicle speed, road surface characteristics, and tread design were found to be major factors affecting automobile tire noise. The effect of pavement surface is more significant for automobile tires than for trucks since the texture within the tire-road interaction zone is on the same scale as the tread element spacing typical of passenger car tires. Although load and wear are significant factors for truck tires, they do not affect car tires as much because the majority of automobile tires use rib tread designs. The limited data available in the literature indicated that such factors as inflation, number of plies, tire dimensions, and tire cord material are not significant factors affecting tire noise. The appendices include the parametric study results and instrument descriptions. Tread element patterns are illustrated.

by W. A. Leasure, Jr.; D. E. Mathews; M. A. Cadoff  
National Bureau of Standards, Washington, D. C. 20234  
Rept. No. DOT-TST-76-4 ; 1975 ; 80p 17refs  
Sponsored by the Department of Transportation Office of Noise Abatement, Washington, D. C. 20590.  
Availability: NTIS

HS-017 846

HS-017 846

# **ALCOHOL AND MARIJUANA EFFECTS ON STATIC VISUAL ACUITY**

Static visual acuity was measured at two contrast levels (12% and 49%) in ten subjects in a double blind experiment involving five drug conditions of alcohol and marijuana. The five drug conditions were: 0.5 milliliter (ml) and 1.0 ml per kilogram body weight of 95% ethanol; 8 and 15 milligrams delta-9-tetrahydrocannabinol; and a placebo. No statistically significant change in static visual acuity was observed for any of the dose levels at any of the measurement times up to 6 hours following drug ingestion. This is sharply contrasted with the marked decrements in acuity which were found in the same subjects under the same drug conditions when the targets were in motion and required coordinated eye movements for their resolution. All subjects were "social" drinkers and had previously smoked marijuana at least five times (averaging 2-5 marijuana cigarettes per week).

by Anthony J. Adams; Brian Brown; Merton C. Flom; Reese T. Jones; Arthur Jampolsky  
Contract DADA17-73-C3106; Grant KO2MH32904; DA00033.  
Publ: American Journal of Optometry and Physiological Optics, v52 n11 p729-35 (Nov 1975)  
1975 ; 13refs  
Availability: See publication

HS-017 847

# **THE SHOCK ISOLATOR FOR THE BUMPER SYSTEM**

After investigating various methods for meeting the requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 215 for the protection of exterior automotive parts for 1974 model vehicles, Toyota decided on the shock isolator system for its models. Developmental work on the bumper system clarified the correlation between the physical properties of the compressible solid and the mechanical structure and load-deflection characteristics of the shock isolator system. The use of such compressible solids as rubber, metallic sodium, and potassium as a working medium was investigated and silicone rubber was found to have the most preferable characteristics. A number of silicone rubbers were investigated and their molecular weight and cross-linking density changed. In order to determine the dynamic property of the entire shock isolator system, both the performance of the silicone rubber, which affects this dynamic property, and the design of the piston orifice should be taken into account. Test results indicate that the shock isolator system using a compressible solid demonstrates the most efficient performance in the following ways: the load-stroke curves are stable in all circumstances; and an adequate relationship exists between the velocity and the energy absorption.

by Yasuhiko Tsuzuki; Akira Suganuma; Hiroyuki Ono; Toshimitsu Kobayashi  
Toyota Motor Co., Ltd. (Japan); Aisin Seiki Co., Ltd. (Japan)  
Rept. No. SAE-750008 ; 1975 ; 10p  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HSL 76-05

HS-017 848

# **PERFORMANCE CHARACTERISTICS OF ELASTOMERIC BUMPER FASCIA**

A comparison of the material performance, processing differences, and cost implications of the following material candidates for automotive exterior fascias is presented: reaction molded thermoset urethane; thermoplastic urethane; and glass-fiber reinforced EPDM (ethylene propylene diene monomer) rubber. When considering large moldings, thermoset urethane is the most economical means of production. The technical information and economic analysis presented are based on firm data established from a production proven operation. There is no doubt that future growth of flexible exterior body panels and bumper fascia for the U.S. automotive industry will be based primarily on the technology of reaction molding of thermoset urethanes.

by Hartley A. Silverwood  
McCord Corp., Davidson Rubber Co., Inc.  
Rept. No. SAE-750007 ; 1975 ; 8p 5refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 849

# **THE APPLICATION OF ELASTOMERIC BUCKLING COLUMNS IN AN ENERGY MANAGEMENT BUMPER SYSTEM**

In an Energy Management Bumper System (EMBS), maximum energy-absorption efficiency is achieved with a 0square wave' load/deflection response. Laboratory and barrier impact tests (two and five mph barrier impacts for a 4,500 test vehicle) show that elastomeric columns provide essentially square wave response during the buckling stage of column deflection. Of the materials tested, high diene-low Mooney EPDM (terpolymer of ethylene, propylene, and a diene) materials fabricated into hollow cube absorber units exhibited square wave efficiencies of 85 to 90% and were found to be the most suitable elastomers for an EMBS application. The efficient use of the elastomeric absorbers in an EMBS was accomplished by placing a metal face plate in front of the units to distribute the impact force across the face of the vehicle. This concept was applied to an engineering design for a 3,000 lb vehicle EMBS that would handle impacts at 5 mph in compliance with Federal Motor Vehicle Safety Standard No. 215. Schematics, exploded views, and drawings of the EMBS assembly are provided.

by J. H. Tundermann; G. M. Larson; R. B. Anderson  
International Nickel Co., Inc.; Pioneer Engineering and Mfg. Co.  
Rept. No. SAE-750011 ; 1975 ; 15p 16refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.  
Availability: SAE

HS-017 850

# **ALCOHOL, DRUGS, AND TRAFFIC SAFETY. PROCEEDINGS OF THE INTERNATIONAL**

**CONFERENCE (6TH) TORONTO, SEPTEMBER 8-13, 1974**

The following aspects of the interrelationship between traffic safety and alcohol and drugs are examined: the epidemiology of alcohol and drug related traffic accidents; pharmacological, physiological, and psychological aspects relevant to driving impairment; methods of analyzing for alcohol and drugs in the human body; aspects of the control and prevention of drinking-driving; and public information and educational campaigns on drinking-driving. Patterns of drug and alcohol abuse in a variety of communities and countries are discussed in detail. Local, state, and national legislative measures designed to counter the problems of drinking-driving are described and evaluated. The effectiveness and accuracy of various instruments for measuring blood alcohol concentration are investigated. The effects of alcohol and drugs on driving ability are discussed. The effect of public education campaigns with regard to drinking-driving on behavior patterns and accident statistics are examined.

by S. Israelstam, ed; S. Lambert, ed.  
Addiction Res. Foundation of Ontario, Toronto, Canada  
1975 ; 908p refs

Includes HS-017 851--HS-017 938. Conference held in association with the International Com. on Alcohol, Drugs, and Traffic Safety and the International Council on Alcohol and Addictions.

Availability: Corporate author

HS-017 851

**EPIDEMIOLOGIC ISSUES ABOUT ALCOHOL, OTHER DRUGS AND HIGHWAY SAFETY**

Epidemiologic principles and their applications to analysis of highway safety problems related to the use of alcohol and other drugs are discussed. One problem area is the need to set priorities for research and action. A model of frequency and quantity of deviance has been proposed to provide a guide to the effect of a drug on traffic safety. This model states that the more frequently a drug is used in the highway setting, the more often it is likely to be a problem and that the more impairing the effect of the drug, either because of its inherent nature or because of the usual amount consumed, the more likely there is to be a problem. Based on this model, only alcohol, marihuana, and tobacco can be identified as of potentially major importance to highway safety at this time and on this continent. Alcohol appears to contribute to the hazard of the other two drugs. Any epidemiologic study must consider both the factors which may affect the occurrence of the problem and the perceptions of the extent of the problem. Varying definitions of a highway fatality, failure of studies to include environmental and other variables that may interact with alcohol and other drugs, evaluation studies which do not use a two by two design, and data that contain large numbers of false negatives and false positives have created a large body of literature having data that are of unknown comparability. Research on the role of marihuana usage in traffic safety indicate that the effects of the use of marihuana are less impairing than the effects of the use of alcohol and that there are not enough crashes or near crashes which can be attributed to the effects of this drug to result in excessive risk at this time.

by Julian A. Waller  
University of Vermont, Dept. of Epidemiology and  
Environmental Health, Burlington, Vt.  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p3-11

1975 ; 25refs

Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974.

Availability: In HS-017 850

HS-017 852

**ALCOHOLICS AND SOCIAL DRINKERS: CHARACTERISTICS AND DIFFERENTIATION**

A variety of criteria can be used to make a diagnosis of alcoholism. Definitions of alcoholism may depend on the quantity imbibed, the degree of loss of control, social consequences, physiological and clinical criteria, and/or psychological parameters. The choice of diagnostic criteria has often been directly influenced by the goals of those using the criteria. These goals may include: desire for early detection; establishing a prognosis; or absolute certainty of diagnosis. Each diagnostic criteria has some drawback, even though it is a reasonably firm criteria of alcoholism. The best means of detecting alcoholism is a combination of the most diagnostic and frequently occurring factors with considerable reliance on those that are a direct consequence of excessive and chronic drinking. The Michigan Alcoholism Screen Test (MAST) provides such a tool for identifying alcoholics and differentiating between alcoholics and social drinkers. The MAST now consists of 24 questions which can be administered or self-administered in 10 to 15 minutes. It has a simple, comprehensible scoring system which does not require the presence of a statistician or a computer bank. The scoring system gives each question a weighted value based on its discriminatory power, with three 5 point questions considered as diagnostic. A copy of this screening device is included.

by Melvin L. Selzer  
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48104

Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p13-20  
1975 ; 18refs

Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974.

Availability: In HS-017 850

HS-017 853

**ROADSIDE SURVEYS, DEMOGRAPHICS AND BACS [BLOOD ALCOHOL CONCENTRATIONS] OF DRIVERS**

Roadside surveys, demographic information, and data on the blood alcohol concentrations (BAC) of drivers can all be used to assess the effectiveness of programs designed to reduce the role of alcohol in traffic safety problems. The Alcohol Safety Action Project (ASAP) in Washtenaw County, Michigan, conducted a roadside survey in which drivers were asked to agree to be interviewed and/or to give a breath sample for BAC analysis. Of those who gave a full interview, only 6% were above 0.10% BAC, while of the group which gave a sample but no interview, 22% were at 0.10% BAC or greater. ASAP roadside survey data indicate that: the reported origin and/or destination of the trip is significantly related to the BAC of the driver; there appears to be no significant relationship between

the absence or number of passengers and the driver's BAC; drivers aged 21 through 55 are the most likely to have some alcohol and significantly more likely to have illegal BAC's than other drivers; men are less likely to be alcohol free and more likely to be over the illegal limit than are women; single people show the largest proportion of alcohol free drivers and the smallest proportion of illegal BAC's; there is some slight evidence that low income, lower socio-economic status groups are more likely to be on the road at significant BAC's and are less likely to be alcohol free than are upper socio-economic status groups; there is no apparent difference in the use of safety belts between drinking and non-drinking drivers; and that individuals with no accidents in the past 3 years were more likely to be using alcohol. Analysis of data collected through roadside surveys at ASAP sites indicates that these programs have resulted in a slight but significant reduction in the proportion of drivers with BAC's above 0.05%.

by Robert B. Voas  
National Hwy. Traffic Safety Administration, Office of Alcohol Countermeasure, Washington, D.C. 20590  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety, Toronto, 1975, p21-31  
1975 ; 7refs  
Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 854

#### **DRINKING AND DRIVING IN THE NETHERLANDS OVER A FOUR-YEAR PERIOD**

The Institute for Road Safety in Holland (SWOV) has conducted three roadside surveys into drinking habits: one in 1970, one in 1971, and one in 1973. The primary purpose of these surveys was to collect information on the degree and pattern of alcohol usage by drivers prior to the introduction of a legally prescribed blood alcohol concentration (BAC) limit. Each of the three survey sites at each of 30 municipalities was visited once during the survey year by a research team. Drivers were asked to permit a 10 minute interview and to provide a blood sample and take two breath tests. In 1970, 2,690 of the 3,141 drivers asked cooperated; in 1971, 2,983 of the 3,417 asked cooperated; and in 1973, 2,134 of the 2,617 asked participated. Both a multivariate analysis and simpler analyses of selected variables were conducted. The personal variable which was found to have the most striking relation to BAC was the sex of the driver; men were found to have drunk far more than women. Drinking increased rapidly from early to late at night. Alcohol use of drivers increased over the years for both men and women and both early and late at night, but particularly for drivers coming from pubs or bars. In this sample, alcohol consumption increased rapidly with age up to about 50 years. However, younger drivers comprised the larger part of motorists coming from pubs and bars. The general relation for age and BAC was found to be slightly U-shaped with the 25 to 35 year group scoring highest late at night.

by P. C. Noordzij  
Institute for Rd. Safety Res. SWOV, Voorburg, The Netherlands  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety, Toronto, 1975, p33-9  
1975

Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 855

#### **CHARACTERISTICS OF LATE-NIGHT, WEEKEND DRIVERS: RESULTS OF THE U.S. NATIONAL ROADSIDE BREATH-TESTING SURVEY AND SEVERAL LOCAL SURVEYS**

In the fall of 1973 the Highway Safety Research Institute of the University of Michigan conducted the first nationwide roadside breath testing survey in the United States. It was decided to conduct this national survey, which was designed to obtain reliable estimates of the extent of driving at various levels of alcohol impairment for the United States as a whole, only on Friday and Saturday nights between the hours of 10:00 p.m. and 3:00 a.m. Obtaining the assistance of local police officials in conducting the survey proved to be a problem in some areas. A controlled probability scheme was used to select a limited number of survey sites. Four or eight roadside sites were selected for each of the 34 communities selected for the survey. The Omicron Intoxilyzer and the Intoximeters Field Crimper were used for testing blood alcohol concentrations (BAC's) at the survey sites. Almost half of the drivers interviewed said that they had drunk alcoholic beverages some time during that day, and 22.6% registered a BAC of 0.02% or more. About 12% of the drivers had been drinking to an extent great enough to impair their driving performance. Five percent registered at a BAC considered illegal in every state. The proportion of drinking drivers increased later at night. Survey data indicates that drinking drivers may be an even more serious problem on Saturday nights than on Friday nights. The most extensive drinking was found among males and among drivers aged 25 to 44. Disproportionately high percentages of impaired drivers were found among Blacks, non-high school graduates, divorced and separated persons, and blue collar workers. In addition, slightly higher impaired driving rates were noted among unaccompanied drivers, among drivers with relatively low annual mileages, and among drivers on relatively short trips. Results are tabulated.

by Arthur C. Wolfe  
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48105  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety, Toronto, 1975, p41-9  
1975

Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974. Complete rept. on this survey, entitled "1973 U.S. National Roadside Breathtesting Survey: Procedures and Results," is available from NTIS as HS-801 241.

Availability: In HS-017 850

HS-017 856

#### **PATTERNS OF BLOOD ALCOHOL CONCENTRATIONS AMONG DRIVERS**

The first phase of a research project intended to measure the effects of attempts made to reduce the frequency of driving after drinking in the driving public of a typical county is discussed. The objectives were to establish a baseline of breath alcohol levels, determine demographic characteristics, describe drinking and driving behaviors, and obtain information on media usage by the drivers. Howard County, Indiana, was selected for the project, which involved a total of 1,919 interviews conducted at 275 sites in the county. The number of sites for each road type in the county was: 4-lane, 73; 2-lane, 73; city streets, 69; and county roads, 49. The interview in-

cluded questions designed to show demographic data, driving characteristics, drinking behavior, and media usage. Alcohol levels were measured by the Borkenstein technique. A control sample from Grand Rapids, Michigan, was analyzed for selected comparisons with the Howard County data, including: the frequency of interviewees at various alcohol levels; the frequency of alcohol level by sex; the frequency of alcohol level by ethnic group; the frequency of alcohol level by age; alcohol level by marital status; alcohol level by education; alcohol level by occupational level; the frequency of place of departure, day of week, mileage driven, and reported drinking and driving frequency by alcohol level; the county of origin by road type; and the use of newspapers, radio, television, and movies by those interviewed. The extensive results are tabulated.

by Bernard H. Fox; Robert F. Borkenstein  
National Cancer Inst., Bethesda, Md. 20014  
Contract PH-86-67-149  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p51-67  
1975 ; 2refs  
Paper from the Proceedings of the International Conference  
(6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 857

#### **PATTERNS OF DRUG ABUSE AND THEIR RELATIONSHIP TO TRAFFIC ACCIDENTS**

Most drugs seen in cases presented in the emergency rooms of hospitals and those involved in traffic accidents are very similar. Most of these drugs originate as over the counter and prescription drugs. A study conducted in 1968 which used both a questionnaire and a chemical analysis on body fluids of people involved in traffic accidents showed that 705 of the 3,409 drinking drivers had engaged in some concurrent drug usage. Although at least 107 different types of drugs were named, the following categories accounted for about half of the sample: tranquilizers, analgesics and antipyretics, sedatives and hypnotics, and analgesic narcotics. Analysis of the body fluids of emergency room patients suspected of drug involvement by the Clinical Laboratory of the Addiction Research Foundation in Toronto, Ontario, Canada, over a 9 month period from October 1972 through June 1973 showed that 938 of the 1,560 cases studied were positive for one or more drugs, including ethanol. The use of a questionnaire type survey has been shown to be very conservative in that few of the drugs used are reported. It is suggested that a comprehensive drug screening must be performed on every person suspected of being an overdose case or traffic accident victims suspected of drug use. By monitoring the overdose scene in the local hospital, a minimum comprehensive list of drugs could be drawn up. This would help towards a more thorough investigation and would save time so that the difficult cases can be handled by the more sophisticated instrumentation, such as gas chromatography, mass spectrometry, and computer techniques.

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Canada M5S 2S1  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p69-72  
1975 ; 9refs  
Paper from the Proceedings of the International Conference  
(6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 858

#### **ALCOHOL AND ROAD ACCIDENTS IN GREAT BRITAIN**

Legislation imposing a legal limit of alcohol in the blood of drivers of motor vehicles was introduced in Great Britain in October 1967. Subsequent trends in casualties, particularly the changing patterns over the years for drivers of different ages, for different classes of road user, and the importance of hour and day when accidents occur, are examined. Casualties were reduced by 11% overall and by 34% during the main drinking hours for the first year after the legislation became effective. However, the proportions of casualties in the main drinking hours have been increasing since 1968 at a rate which, if unchecked, will revert to the 1966/1967 levels by 1975/1976. Reductions in passenger casualties has tended to decline less with time than the driver casualties, and pedestrian casualties have not changed much. Driver casualties have been reduced more among older drivers than among drivers under 30 years old. Although the initial substantial reduction in casualties has not been maintained, it is concluded that there is still a residual benefit. Blood alcohol concentration in excess of the prescribed limit of 80 milligrams per 100 milliliters were found in 25% of the drivers killed in 1966, while this figure was reduced to 15% in the first year. However, since 1971, the 25% rate has been consistently exceeded. In a sample of 2,049 drivers involved in 1,164 accidents, the driver was known to have consumed alcohol in 272 instances, and the amount consumed was considered sufficient to impair driving ability seriously in 118 cases. Loss of control and single vehicle accidents are much more associated with alcohol than other types of accidents.

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Toronto, 1975, p73-83  
1975 ; 9refs  
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Wales and The Chief Constables throughout Great Britain.  
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(6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 859

#### **ALCOHOL, DRUGS AND CARBON MONOXIDE IN TRAFFIC FATALITIES IN PUERTO RICO**

Traffic fatalities are the largest single cause of death due to accident in Puerto Rico, and alcohol is the major influencing factor in these fatalities, either through cases of driving while intoxicated or walking while intoxicated. Of the 577 traffic deaths in 1973, 508 cases were submitted for measurement of blood alcohol concentration (BAC) and for screening for common depressant drugs and carbon monoxide following autopsy. The 508 traffic fatalities which were studied were separated into the following categories: pedestrians, passengers, drivers, sex, age, occupation, day of the week, and hour of the day. Pedestrians accounted for 37% of the traffic fatalities, while passengers and drivers each accounted for about 25%. Sunday was found to be the day with the most fatalities, and 243 of the 508 fatalities occurred on the weekend. Of the 386 cases in which BAC was determined, only 44% showed positive alcohol content, of which 97% were males. About 39% of the alcohol positive cases were drivers, and about 60% of the drivers analyzed were found to have alcohol in their bodies.



Thirty percent of the pedestrians were alcohol positive cases. Sunday accounted for the largest number of positive alcohol cases, followed closely by Saturday; together these two days accounted for 52.9% of the alcohol positive cases. The largest number of male positive alcohol cases fell into the 20 to 30 age group. Men were found to account for about 80% of the alcohol positive cases. Only three of the fatalities tested positive for depressant drugs, and all three had used phenobarbital and tested negative for alcohol. Twenty-two cases were found to have 5% carboxyhemoglobin concentrations in their blood, of which 13 also had BAC's of 0.05% or more. Of the 46 male fatalities between the ages of 15 and 20, nine showed positive for alcohol, of which six were drivers. None of the 14 females in this age group tested positive.

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1975 ; 22refs

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HS-017 860

#### **ALCOHOL, MARIJUANA AND OTHER DRUG PATTERNS AMONG OPERATORS INVOLVED IN FATAL MOTOR VEHICLE ACCIDENTS**

The Boston University Traffic Accident Research Team has conducted an investigation of 300 motor vehicle accidents involving a personal fatality in the Boston metropolitan area over a 30 month period with the major focus of attention being on the historical and focal human factor variables associated with the operator of the vehicle judged to have been most responsible for the crash. Fifty-two percent of the operators considered most responsible were known to have been under the influence of some drug at the time of the collision. About 46% of the operators were influenced to some degree by alcohol, 16% had been smoking marijuana, and 8% had been using some street or pharmaceutical drug. Some combination of these drugs were used by 16% of the operators. A Risk Taking Behavior Scale (RTBS) was developed to identify the relative degrees of risk-taking behavior in order to determine if there might be some risky behaviors typical of certain groups of motor vehicle operators which could be used to assist in the early identification of the high risk driver. The application of the RTBS to a group of alcohol influenced drivers (Group A) and a group of operators without known alcohol influence (Group B) showed that the drivers in Group A presented a weighted risk score of 7.0, as compared to a score of 5.4 for Group B. Of the operators considered most responsible for accidents, 45% were known to have smoked marijuana with some frequency. Sixteen percent were known to have been involved in accidents after they had been smoking marijuana. It is concluded that items in the RTBS, variables associated with antisocial behavior, and problems correlated with previous social errors resulting from alcohol use distinguished the alcohol influenced driver from other drivers and can be used to identify in advance the drinking driver likely to become involved in a fatal accident as the most responsible operator.

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1975

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HS-017 861

#### **ALCOHOL, DRUGS, AND DRIVING: RELATIVE PRIORITIES FOR BASIC AND APPLIED RESEARCH**

In October 1972, the National Highway Traffic Safety Administration sponsored the Vermont Symposium on Alcohol, Drugs, and Driving which was designed to assess the status of present knowledge and to consider relative priorities for both basic and applied research in those areas germane to its theme. The 35 invited participants attending the symposium were asked to attend eight sessions identifying particular topics of relevance within selected areas of concern and then to rate keywords discussed during the session. The following four separate rating tasks were required: rate present knowledge on a 15 point scale ranging from no knowledge to total knowledge; assign a priority for basic research in terms of informational yield on a 7 point scale; assign a priority for applied research in traffic safety on a 7 point scale; and rate the respondent's own qualifications for judging the specific area on a 7 point scale. The areas selected as having the highest priority for research in the area of basic research on alcohol were alcohol influences on basic neurophysiological activities, on psychological processes, and in combination with other conditions of the organism. These same categories were given highest priority for basic research on drugs and for applied research on drugs and alcohol. Highest priority for applied research on the epidemiology of drugs in highway safety was given to the incidence and prevalence studies necessary in the exploratory stage of investigating a new problem. Highest priority on epidemiological aspects of alcohol in highway safety were given to the interaction between alcohol and drugs, as well as to the study of individual differences. It was concluded that more incidence and prevalence studies are necessary before drug countermeasure programs can be undertaken. High priority alcohol countermeasure research choices included enforcement by police surveillance and rehabilitation by behavior modification. Titles, chairmen/reviewers, and rated keyword topics for the eight sessions of the symposium are listed.

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1975 ; 14refs

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Availability: In HS-017 850



HS-017 862

### HUMAN AND ENVIRONMENTAL FACTORS IN ALCOHOL-RELATED TRAFFIC ACCIDENTS

A study of the human and environmental factors in alcohol related traffic accidents was conducted in Bernalillo County, New Mexico. Data collected on about 1,000 drivers at an Alcohol Safety Action Projects (ASAP) Roadside Survey in 1974 indicates that the study area shows greater-than-average use of alcohol and occurrence of drinking and driving and a higher proportion heavy drinking. Drinking drivers involved in 200 traffic accidents were selected for this study. This study concluded that the alcohol-involved driver appears to generally be male, young, disproportionately Spanish or Native American origin, unmarried, and a manual worker. He is relatively inexperienced with his car, often has no driver's license, and is driving from a friend's to his home. He is typically impaired well beyond the legal limit when involved in an accident and his history and alcohol use patterns indicate that a majority are problem drinkers. The accident typically involves a single driver in a single vehicle striking a fixed object on or off the roadway. Environmental factors do not appear to be significant. Human error was found to have precipitated the accident in almost all cases. The most common human errors include: lack of comprehension; misjudgment; improper driving; and speeding. The vehicle driven by the drinking driver is typically old and in a generally poor state of maintenance and repair. It also appears that alcohol accidents are modally quite different from the general vehicle accident: single vehicle accidents occur in 68% of the alcohol group's crashes but in less than 12% of all accidents in Albuquerque; fixed object collisions are 57% of the alcohol group's crashes, but 8% of all accidents; and 84% of alcohol related accident involved drivers are male, but only 67% of all drivers in accidents are male.

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Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p129-45  
1975 ; 14refs  
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HS-017 863

### THE PREVALENCE OF DRUGS IN FATALLY INJURED DRIVERS

The National Highway Traffic Safety Administration is currently sponsoring programs to determine the frequency with which various drugs are found in fatally injured drivers. Specimens of blood, urine, bile, and alcohol swabs from the fingers and oronasal area were collected from 710 fatally injured drivers between December 1971 and September 1973. The blood was analyzed for drugs, including alcohol; the urine and bile were analyzed for drugs, excluding alcohol; and the alcohol swabs were analyzed for marihuana. The following observations were made: the only drug significantly over-involved in the case of drivers at fault in the accidents was alcohol; alcohol was the only drug over-involved in single vehicle crashes; alcohol was the only drug upon which time of day was a significant influence; geographical region was not a significant factor for any response; age was a significant factor only with respect to alcohol; sex was a factor with respect to alcohol and nicotine usage; and the season of the year was

found to be a factor with all responses except alcohol and nicotine, with marihuana being a spring and summer drug and aspirin being associated with winter. It is concluded that alcohol was by far the most dangerous drug examined in the study. The drug group tranquilizers, antihistamines, and stimulants did not furnish a large enough sample to be stratified meaningfully, although results of the study indicate that males were over-represented among users of tranquilizers and antihistamines, and that young people were over-represented among those who used stimulants. Tabulated results of drug findings are fully detailed.

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Toronto, 1975, p147-58  
1975

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HS-017 864

### THE RELATIONSHIP BETWEEN SELF-REPORTED DRUNKEN DRIVING, ALCOHOL CONSUMPTION, AND PERSONALITY VARIABLES AMONG NORWEGIAN STUDENTS

A questionnaire dealing with drunken driving and personality variables was circulated among a representative sample of students at the University of Oslo, in Norway, in 1969. The 1,066 respondents represented 78% of the sample. Of the 251 students who admitted to having driven at least once with an alcohol concentration in excess of the statutory limit, only two admitted having been arrested for drunken driving. Among the 21% of the men and 7% of the women respondents who said they had drunk as much as 7 liters of pure alcohol during the last year, almost 50% had driven with an alcohol concentration in excess of the legal limit. For both men and women, a greater correlation was found between drunken driving and drinking frequency than between drunken driving and quantities of alcoholic beverages usually drunk at one time. Self-reported drunken driving, which had very rarely led to an accident or come to the attention of the police showed a definite correlation with the general consumption of alcohol and with signs of potential drinking problems and tendencies towards aggressive conduct when intoxicated. No correlation was found between drunken driving and a person's neuroticism index. A definite relationship was noted between drunken driving and aggressiveness, an inability to control impulses, and an inability to plan ahead. There was a clear relationship between drunken driving and suicidal impulses and sexual problems for women, but not for men. The personality traits that predispose women to drunken driving appear to differ from those that so predispose men. Self-reported drunken driving for both men and women was found to correlate with a criminality index based on self-reported criminal offences such as vandalism, robbery, all kinds of theft, smuggling, and illegal hunting and fishing. A clear correlation between drunken driving and smoking exists for both men and women.

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Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p159-68  
1975 ; 9refs

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HS-017 865

### ALCOHOL ABUSE IN FIRST OFFENDERS ARRESTED FOR DRIVING WHILE INTOXICATED

An investigation designed to evaluate and manage the problem of the intoxicated driver was conducted in Philadelphia, Pennsylvania, from January 1973 through June 1974. A set of 15 questions designed to measure an individual's drinking pattern and its effect on one's social and economic functioning was administered to the 2,647 drivers who had been arrested in the city for the first time driving while intoxicated (DWI) and who had no previous major arrest record. All subjects were referred from the court system to the assessment program. About 58% of the offenders reported a constant regular abuse of alcohol. The highest percentage of problem drinking was found in the 20 to 24 age group and the type of drinking typical at this stage decreased with increasing age. An overwhelming 93.5% of the first offenders arrested for DWI were male. Fifty-two percent of the sample were married, and married individuals showed significantly less alcohol impairment as a group than any non-married group. The DWI sample had a higher concentration of black persons than the population of the city. Blacks as a group exhibited more serious drinking patterns than Whites and tend to become more serious drinkers at a later age than do Whites. The apparent lack of insight into the severity of their drinking problems and the almost non-existent motivation to obtain treatment indicate that some form of compulsory program will need to be instituted for these offenders. It is recommended that such a program be designed to encourage more responsible use of alcohol, especially with regard to drinking and driving, rather than at total abstinence.

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Toronto, 1975, p169-74  
1975 ; 18refs

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HS-017 866

### DRINKING CHARACTERISTICS OF DWI INDIVIDUALS SCREENED AS PROBLEM DRINKERS

An assessment and referral program for driving while intoxicated (DWI) persons conducted in Phoenix, Arizona, using clients arrested for DWI, was designed to: report prevalence rates of a wide range of symptoms of problem drinking, rather than simply classifying clients as problem drinkers or not problem drinkers; report current drinking problem symptoms of selected DWI clients; and report drinking problem symptoms of clients screened as high risk problem drinkers. The assessment program identified 281 clients--about 37% of the total DWI's screened--as high risk problem drinkers during a 5 month period. These clients were referred to an interview for further assessment of their problem drinking behavior and were referred to a rehabilitation program. Ninety percent of these clients were male; 85% were between the ages of 20 and 49; over 60% were White Anglo-Saxon and about 23% were Mexican-Americans; the majority were married, although over 30% were either divorced or separated; and the majority were engaged in blue collar work. Almost 45% of the clients usually drank to a point of intoxication; 34% had experienced

blackouts; 14% had shakes in the morning after drinking; and 11% had at some time been intoxicated at work. Almost 25% said that drinking had adversely affected their health; over 50% reported an adverse effect on their family relationships; and 16% had problems at work resulting from their drinking. About 22% considered themselves problem drinkers and 22% wanted help to change their drinking behavior. About 80% of the clients scored above the cut-off point for problem drinkers on a weighted questionnaire about drinking habits. It is suggested that the contrast between the 20% rate of self-assessment as a problem drinker and the 80% rate classified as problem drinkers indicates that the motivation of the drinking driver to recognize and begin to deal with his drinking problem may be one of the major challenges of any rehabilitation program working with this group.

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1975 ; 5refs

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HS-017 867

### THE DRINKING DRIVER: IDENTIFICATION OF HIGH-RISK ALCOHOLICS

A study of the characteristics of drinking drivers conducted in Alberta, Canada, involved study of the following groups of subjects: 201 convicted impaired drivers (Group ID); 200 high risk drivers, who had accumulated 9 to 14 demerit points in 24 months, but who had no alcohol related accidents or convictions for impaired driving (Group HR); 58 institutionalized alcoholics who had never been cited for impaired driving (Group AL); 140 normal social drinkers who scored less than 4 on the Michigan Alcoholism Screening Test (MAST) (Group CN); and 49 regular and frequent consumers of alcohol who exceeded the performance criterion "suggestive of alcoholism" on the MAST (Group CA). A Personal Information Questionnaire (PIQ) was designed as the basic socio-demographic instrument. The Howarth Personality Questionnaire and the Psychoticism, Extroversion and Neuroticism Inventory were also used to assess subjects. In general, the groups were found to be less different on major socio-demographic indices than had been expected, although the groups did differ with respect to their social economic standing. It appears that while high-risk drivers may have attempted to operate vehicles after drinking as frequently as impaired drivers, the impaired drivers may be more readily identified because they are impaired to a greater extent. A clinical analysis of the personality profiles of the various groups revealed that only those subjects in Group AL presented a marked pathology. The results of multiple discriminant analysis attempts seem to demonstrate that the personality tests were incapable of correctly isolating subjects on the basis of their prior driving behavior or involvement with alcohol, except in cases where the involvement with alcohol was probably at an extreme. The data seem to imply that an individual convicted of impaired driving may have a drinking problem and that those with multiple alcohol-related offences may have exaggerated problems in alcohol control.

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1975 ; 20refs

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HS-017 868

# **THE VERMONT DRIVER PROFILE: A PSYCHOMETRIC APPROACH TO EARLY IDENTIFICATION OF POTENTIAL HIGH-RISK DRINKING DRIVERS**

The Vermont Alcohol Safety Action Program (ASAP) developed a Driver Profile questionnaire which was administered to 840 applicants for driving licences in Vermont over a 10 month period and to a control group of 1,283 applicants. The latter group completed only the Biographical Data Schedule, while the first group also completed the Abridged Driver Profile. The Biographical Data Schedule collected information on the following variables: sex; age; educational level of the applicant and each of the parents; student status; employment status; occupational level; number of jobs in the past 5 years; community type; marital status; number of previous marriages; amount of driving experience; driver education status; and estimated annual mileage. The Abridged Driver Profile questionnaire collects data on driving history, drinking history, and social stability-instability. On the basis of the consistent and significant results from the factor analyses, discriminant analyses, and multiple regression analyses of the Driver Profile data, it is concluded that this psychometric approach to identifying high risk drivers is both technically feasible and appears to be sufficiently valid to warrant continued refinement for wider implementation. The Driver Profile questionnaire used in the study could be shortened. The error choice questions seem to be effective in differentiating the various categories of respondents, and it is recommended that the Vermont Error-Choice Test of Driving Skill be included in its entirety. It is suggested that the predictive strength of the Driver Profile could be significantly increased by developing new scales from the existing Driver Profile data which would cut across all items in the total pool.

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1975 ; 36refs

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HS-017 869

# **MASS ARRESTS FOR IMPAIRED DRIVING MAY NOT PREVENT TRAFFIC DEATHS**

A review of the literature reveals that: the role of alcohol as a causal factor in fatal traffic accidents is poorly defined; the level at which alcohol becomes a statistically significant factor in fatal accidents has not been determined; present beliefs about drinking and driving crashes and programs to alleviate the problem are based on incomplete and biased data; and the proportion of all traffic deaths in the United States that may be related to alcohol in some causal fashion is closer to 30% than the 50% generally reported. There is evidence that different countermeasures may be needed for fatal crashes than for collisions in general. Although alcoholics and youth represent special problems, it is only among a minority of those groups that the problem is concentrated. It is suggested that those who are killed while drunk are different in significant ways from those convicted of driving while intoxicated. Mass arrests for driving while intoxicated have proven ineffective. It is suggested that there is a need to identify a larger group of high risk drivers whose deviant behavior leads to crash involvement with or without alcohol and among whom some use alcohol as a triggering device. Rather than the high risk alcohol abusers being a sub-group of all drivers, the alcohol abusers who are involved in violent crashes should be considered a sub-group of a much larger population of high risk drivers. This perspective of the fatal crash problem should not only aid in the identification of high risk drinking drivers, but also the high risk non-drinking drivers. In this manner the 70% of all traffic deaths not related to alcohol could be combatted as well as the 30% that may be related to alcohol in some causal fashion. Real progress can be expected only after the problem is more clearly defined and countermeasures specifically applied.

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Toronto, 1975, p225-37  
1975 ; 26refs

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HS-017 870

# **IDENTIFICATION OF THE DRINKING DRIVER**

A study conducted in Victoria, Australia in 1969 was designed to identify the drinking driver by his pattern of traffic convictions. Data for the study consisted of the driving and criminal records of the following groups of drivers: a control group of 649 Victorian drivers; an alcoholic group of 434 persons; and a group of 458 breathalized drivers. The study showed that alcoholics have a distinctive pattern of offences. They were significantly more likely than controls to be convicted of offences related to drunken driving, dangerous driving, accidents, unlicensed driving, and illegal use of motor vehicles. This pattern of offences extended to convicted drinking drivers and suggested that alcohol was an unrecognized factor in more serious offences. The repetition of drinking-driving and serious offences and the frequent high blood alcohol concentrations (BAC) of the drivers involved indicated that many of these drivers often drove while intoxicated. The determination of the BACs of the persons involved in these offences,

together with this pattern of offences, should be used as a screening device to identify problem drinkers for subsequent treatment. License withdrawal was shown to be an ineffective answer because of the continued convictions of these drivers. The criminal records helped to indicate that while alcohol was a factor in traffic offences, there were other factors involved, as shown by the different number of records among the alcoholics. The correlation between types of traffic convictions and criminal records, and the similarity of the types of offences among a driver's convictions, suggested that many drivers frequently drive or act in that manner.

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1975 ; 8refs  
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HS-017 871

### THE IMPORTANCE OF PSYCHOSOCIAL FACTORS ON DRINKING IN ALCOHOLICS: RELEVANCE FOR TRAFFIC SAFETY

Alcoholic drinking is a complex process usually involving the following components: situational stress; arousal of an effect; activation of a desire to drink; and the act of drinking itself. The interrelationships of these four components in a group of 50 alcoholic inpatients and the psychodynamic implications of the findings and their relevance to traffic safety are discussed. The extremely strong association between desire to drink and actual drinking reported by these patients indicates that the desire to drink was tantamount to drinking for these people, regardless of the precipitating context or the affect aroused. There was essentially no break in the process once the desire to drink had been activated. Depression was found to be more often associated with a desire to drink than anxiety or anger, and stress in the self or interpersonal spheres was more likely to be related to a desire to drink than stress at work. Since the alcoholic is at greater risk to himself and others as a driver only when he is drinking, it is important to learn more about the specific circumstances most likely to be associated with drinking. Situations which are unstructured and which activate feelings of depression all cause the alcoholic to feel powerless and out of control. Driving may provide a structured activity, offer temporary relief from dysphoric feelings, provide a temporary exhilaration, and provide a sense of control and power. Drinking and driving may be two of the few activities which the alcoholic knows that he can do himself to dissipate his feelings of impotence and loneliness. Awareness of this attempt at coping served by driving should help in the planning of more effective educational and preventive programs in this area.

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1975 ; 12refs  
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HS-017 872

### DRUG EFFECTS ON EMOTIONS: RELEVANCE TO DRIVING ACCIDENTS

Laboratory experiments which contribute to the understanding of how driving behavior is affected by low and high arousal levels induced by different aspects of the driver's environment, by alcohol and other drugs, and by drug-environment interactions are reviewed. Safe driving requires medium arousal. At low levels, driving performance is characterized by inattention and emotional unresponsiveness; at high levels by disorganization and impulsiveness. Centrally acting drugs, stimulants, and depressants are powerful determinants of arousal level, and drug effects may either enhance or reduce effects of concomitant environmental influences. The largest deviation from an optimal arousal level is likely to occur when a monotonous situation is combined with the action of a depressant drug. Stimulant drugs may counteract the decreased wakefulness induced by a monotonous situation and a stressful environment may counteract the effects of a sedative drug. The effects of drugs on driving behavior are only partly determined by the pharmacological properties of the drug. The driver's cognitive appraisal of his own state and of the external situation will guide his choices and decisions. Among emotional factors, fear reduction is an important component in risk taking behavior. Alcohol intoxication increases the probability that a driver will make bold, risky decisions when faced with complex choices. Fear reduction may also be manifested as aggressive behavior. This increased risk taking is often the cause of traffic accidents.

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1975 ; 20refs  
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HS-017 873

### THE PHARMACOKINETIC COMPONENT OF DRUG EFFECTS ON DRIVING SKILLS

Although studies of the effects of drugs on driving skills attempt to determine if a specific dose of a drug has some predictable influence in a particular driving related task, there is overwhelming evidence in the literature that the serum concentrations are better predictors of therapeutic effect or toxicity than dose for many drugs. Among the factors which can alter the relation of drug dose and serum concentration are: the bioavailability of the dosage form administered; the completeness or rate of absorption by the kidney or in the bile; and binding of drug to tissue or serum proteins. There are marked inter-individual differences in each of these due to genetic factors, co-existing disease, and the concurrent administration of other drugs. A study of the interaction of diphenhydramine and alcohol on a co-ordination test and selected driving time showed that the inter-subject variation in performance increases with increased doses. The misconceptions that serum concentrations measurements are not helpful is due to the lack of sophistication in measurement of psychoactive drug effects and application of pharmacokinetic analysis. The vast majority of

studies of drug effects on driving skills have failed to include concurrent measurements of plasma drug concentrations, resulting in literature which is confusing, contradictory, and often uninterpretable. Although widespread, intelligent application and appropriate interpretation of serum concentration measurements of psychoactive drugs in driving skill studies will be difficult and expensive, it is a prerequisite for establishing the scientific facts necessary to the generation of useful statements concerning the influence of drugs on driving.

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Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p271-93  
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HS-017 874

### VALIDITY OF DRIVING SIMULATOR STUDIES FOR PREDICTING DRUG EFFECTS IN REAL DRIVING SITUATIONS

Driver simulator studies are a form of laboratory examination of the effects of a drug on some aspect of driving. Difficulties in constructing the ideal stimulator include the inability to confidently enumerate all the behavior demands of driving and the limitations of existing technology. Simulators may be either programmed, in which case the driver's reaction to the visual scene has no effect upon the presentation, or unprogrammed, in which case the presentation changes in response to the driver's behavior. No simulator samples all stimulus inputs and demand characteristics of driving. A drug might be potentially detrimental to some behavior mechanism not required in the simulator. It is concluded that there is considerable reliability in the sense of agreement among simulator studies when the emphasis of the analysis is on the psychological function affected by the drug, rather than on the response variable in which the particular psychological function is exhibited. In order to examine the issue of the validity or relevance of the results in the simulator, it is necessary to first isolate the behavioral functions that are being affected by the drugs. The results of simulator studies on the effects of alcohol agree on the nature of the impairment in accidents.

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HS-017 875

### EFFECTS OF ALCOHOL ON VISUAL ACCOMMODATION AND EYE MOVEMENT LATENCY

Two components of the visual system, accommodation and horizontal saccadic eye movement, were examined using three subjects with various blood alcohol concentrations (BAC). The apparatus used to measure the monocular accommodation response time was a triple-function ocular monitor which uses infrared techniques. The accommodation parameters which were specifically measured are the latency response time and the total accommodation time. The range of BAC's for the accommodation experiments was from 50 to 100 milligrams per 100 milliliters. Twenty-five positive accommodations and 25 negative accommodations were measured prior to alcohol ingestion for use as a control and were measured at each determined BAC for comparison with the control. A projector constructed from a low power helium-neon laser was used to display a stimulus in the tests to measure eye movement latency. An eye movement detector was constructed from a pair of eyeglass frames and photo transistors. In general, the accommodation responses under the influence of alcohol were found to be slower than the controls by a factor of 10 to 40 percent. The degree of retardation of the accommodation process was found to increase as a function of BAC. The mean value of saccadic eye movement latencies that occurred at the maximum BAC levels was .314 seconds. When compared to the mean normal value of .248 seconds, a 26% increase in latency is seen. Although the eye movement latency increased with the ingestion of alcohol, it appears that it does not increase proportionately with the BAC except during the absorption phase of alcohol. Because the principal eye movement made in the operation of a motor vehicle is the horizontal saccade and because the system of accommodation is responsible for a clear image on the retina, the ability to drive safely is seriously compromised by the use of alcoholic beverages, according to these data.

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HS-017 876

### EFFECTS OF SMALL DOSES OF ALCOHOL ON THE EYE MOVEMENTS OF DRIVERS

A test course which provided a similar situation to real driving was used in an experiment designed to determine if such visual deterioration as longer eye fixation time, tunnel vision, and lack of attention switching mechanism could occur under a blood alcohol concentration (BAC) as low as 50 milligrams per 100 milliliters. The driving training track had curved and straight courses where a dummy ejection system was installed. The dummy was clothed and of human size and was generally obscured from the driver's view. The ejection system was operated when the car reached a distance of 14 or 22 meters from the dummy. The Neck Eye-Mark Recorder Model II was used to collect eye movement data. Complete data was ob-

tained for two of the four subjects. For both skilled and non-skilled drivers under the influence of alcohol, saccadic vertical eye movements were increased and horizontal eye movements were decreased. In the drinking driving condition, the distribution of eye fixation points for the non-skilled driver was scattered over a wider area than in the case of the skilled driver; both the whole area and the very dense area tended to shift downward. The fixation area tends to shrink under the drinking driving situation.

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HS-017 877

# **COMPUTER-ELECTRONYSTAGMOGRAPHY: A USEFUL TOOL IN EVALUATING INFLUENCE OF PSYCHOPHARMACOLOGICAL DRUGS ON TRAFFIC SAFETY**

Ten persons participated in short term tests and five persons in a long term test to determine the accuracy, velocity, duration, and reaction times of saccadic eye movements when under the influence of the tranquilizer diazepam or sulpiride, which it is claimed does not interact with the patient's alertness in spite of its neuroleptic and thymoleptic action. Eye movements were recorded by means of the bitemporal electrooculogram (EOG) and fed into a PDP-12 laboratory computer. Subjects were seated facing a TV screen in which a single light spot was displayed. The subjects were instructed to fixate on the target and to track target jumps as fast and accurately as possible. In each experiment 512 eye movements were recorded and analyzed. The computer measured the following parameters for each of the saccadic reaction: latency between target jump and onset of the saccade; amplitude of the saccade; and maximum velocity of the eye movement. No significant difference was found between the short term and long term experiments. Diazepam always produced a significant reduction of saccadic velocity as well as an increased saccadic duration and standard deviation. Sulpiride produced only a slight change. Psychomotor performance under the influence of sulpiride was found to either match or exceed the performance during the better of two normal tests, while diazepam causes a marked hypometria resulting in a standard deviation three times higher than under normal conditions.

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HS-017 878

# **EFFECTS OF LOW AND MODERATE LEVELS OF ALCOHOL ON STEERING PERFORMANCE**

An experiment designed to define the effects of alcohol on the steering task by isolating the components of the cue structure drivers use for controlling the path of a vehicle is described. Eighteen subjects participated in the tests, which were conducted using a driving simulator which provides a visual display of the lateral and longitudinal motions of a simulated vehicle, which are controlled by steering inputs from the subject-driver. Subjects were given either an alcoholic drink or a placebo drink and were instructed to maintain the vehicle in the center of the roadway lane. No significant differences were found between the placebo and alcohol groups for steering wheel displacement, path angle, and yaw rate. Analyses of the variance of the values of the frequency bandwidths showed that: the mean steering wheel displacement frequency bandwidth was reduced at 0.01% blood alcohol concentration (BAC) and at 0.07% BAC in the elimination phase; the mean path angle frequency bandwidth was reduced at all alcohol dose levels; and the mean yaw rate frequency bandwidth was reduced at all alcohol dose levels. Analyses of variance of the RMS (root mean square) values showed that: mean lateral position error RMS was increased at 0.10% BAC and at 0.07% BAC during alcohol elimination and that mean path angle RMS was increased at 0.10% BAC and at 0.07% BAC during alcohol elimination. These results indicate that low and moderate doses of alcohol do have an effect on the driver's steering performance. In addition, the study provides additional information concerning those aspects of the driver's cue structure and response behavior which are affected by alcohol. The effect of alcohol on the driver's steering control task is essentially one of reducing the overall competence to a level more similar to that of novice drivers. The results show that there was generally more indication of impairment in the alcohol elimination phase than at the same BAC level during alcohol uptake.

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HS-017 879

# **VEHICLE-BORNE DRUNK DRIVER COUNTERMEASURES**

The development of an alcohol countermeasures program involving an engineering approach to the problem by General Motors is discussed. Two categories of vehicle-borne systems for detecting driver impairment have been considered: pre-driving tests consisting of breath alcohol analysis and performance testing to identify impairment prior to driving and to inhibit the operation of the vehicle when impairment is identified; and continuous monitoring techniques using psychophysiological parameters and driver performance parameters which would activate warning systems upon identification of impairment. General Motors has placed most of its effort on the development of pre-driving performance tests because of their relative ease of implementation and

promise of more immediate impact. In order for a pre-driving performance test to be effective as an alcohol ignition interlock, it must meet the following objectives: large discrimination against intoxicated individuals; and no discrimination against sober individuals capable of driving. The Critical Tracking Task (CTT) system requires the operator to stabilize the output of a dynamically unstable system whose level of instability increases with time. The CTT system was tested using 71 subjects (45 males and 26 females) ranging in age from 18 to 51. Subjects were trained to use the CTT on a simulator equipped with the device, following which they used a car equipped with the system for 10 days. At the end of this period they were tested in sober and after several alcoholic drinks. The under 30 age group generally showed a lower failure rate under the various blood alcohol concentrations (BAC) than the over 30 age group. All BAC groups deteriorated in performance with the test score decrement ranging from 0.70 with a BAC of 0.10% to 1.5 for the 0.15% BAC. In addition, no subject's average performance on the five post-drink trials was greater than the pre-drink average score.

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HS-017 880

#### **DIFFERENCE IN BLOOD ALCOHOL LEVELS FOLLOWING CONSUMPTION OF WHISKY AND BEER IN MAN**

A series of studies was conducted to define the degree of behavioral and functional impairment following consumption of Canadian beer and whisky and the effect of alcohol beverage dose on blood alcohol response. The central nervous impairment of the 26 subjects following ingestion of alcoholic beverages, as indicated by changes of standing steadiness, was measured using the statometer developed by Goldberg. At the 0.25 grams per kilogram of body weight dose level there were no significant differences between the blood alcohol coordinates for beer or whisky, but at all higher dose levels the differences were statistically significant and the magnitude of these differences increased with increasing doses of alcohol. An increase in body sway occurs as the blood alcohol concentration (BAC) builds up and this reverts to normal coincident with the elimination of blood alcohol. The extent of these changes was found to be greater with whisky than with beer, particularly with the eyes closed. A dose of 0.75 grams per kilogram of body weight of alcohol in the form of whisky or beer, consumed over a period of 25 minutes, will result in greater BAC levels and impairment as measured by the statometer when whisky is ingested than when an equal amount of alcohol in the form of beer is ingested.

by P. Dussault; C. I. Chappel  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
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HS-017 881

#### **SENSORIMOTOR AND PHYSIOLOGICAL EFFECTS OF VARIOUS ALCOHOLIC BEVERAGES**

Sensorimotor and physiological effects of equivalent doses of alcohol in the form of Canadian rye whisky, Canadian beer, and a sparkling table wine were compared with those of a non-alcoholic carbonated control beverage. A total alcohol dose of 1.3 grams per kilogram of body weight was consumed over four hours, beginning one hour after a standard light meal. Sixteen male subjects aged 20 to 35 years, all moderate drinkers, were tested in pairs in a replicated 4 by 4 Latin Square design. Pre-drinking baseline measurements were made on the pursuit rotor, quantitative Romberg tests, skin temperature, heart rate, facial flush, and blood alcohol level. The same measures were repeated at regular intervals over the 4 hour drinking period. The three alcoholic beverages produced blood alcohol curves that did not differ significantly. As compared to the control beverage, the three alcoholic beverages produced increasing impairment over time, which corresponded in degree to the rising blood alcohol levels. There were no significant differences among the three alcoholic beverages on either the sensorimotor or physiological measures at any blood alcohol level. The results of this study indicate that the degree of impairment following alcohol ingestion in a socially relevant manner is dependent not on the type of beverage consumed, but on the resulting blood alcohol concentration.

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HS-017 882

#### **SOCIAL PATTERNS OF DRINKING IN YOUNG PEOPLE AND THE RELATED BLOOD ALCOHOL LEVELS**

A series of experiments designed to determine the blood alcohol concentrations (BAC) in a variety of drinking situations is discussed. The subjects, all males between the ages of 18 and 25, drank beer, white rum, wine, or whisky over varying periods of time and in a fasting condition or with various amounts of food. These studies indicated that a loading dose of 48 grams of ethanol in one hour would cause the BAC to exceed 0.05% whether the individual is fasting or eating. Eight to 10 grams of alcohol causes the BAC to rise by about 0.01% and a continued intake of 16 to 20 grams per hour will result in a rising BAC. The weight of the individual is important only when comparisons are made between persons who are at opposite extremes of the weight range. A survey of 2,000 breathalyzed drivers in Victoria, Australia, conducted in 1973 showed that 42% of the apprehended drivers were aged 25 years or under and that nearly all were male. Only 20% of the licensed drivers are in this age group.



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HS-017 883

### **MEDICAL CONCLUSIONS FROM THE CLINICAL TESTS OF DRUNKEN DRIVERS WITH HIGH ALCOHOL LEVELS**

The relevance of clinical tests in determining the degree of intoxication was investigated in Sweden. In Sweden, one central laboratory analyzes alcohol from suspected drunken drivers, providing uniform information. The research materials used includes the results of the alcotest and the doctor's conclusions about the degree of drunkenness. The doctor's conclusions are given in the form of the following estimations: the subject is slightly, moderately, highly, or not at all under the influence of alcohol, and/or the subject is under the influence of other drugs, ill, tired, or sleepy. Of the 21,711 laboratory analyses of blood alcohol performed in Sweden in 1973, 646 showed a high level of alcohol in either the blood or urine. Clinical conclusions were compared with the actual levels in these cases. In 21% of the cases with high alcohol concentrations the clinical conclusion was that the subject was not under the influence of alcohol or that he was slightly inebriated; in 47.5% of the cases the subject was deemed moderately intoxicated; and only in 21.5% of the cases was the subject judged highly intoxicated. In only about 25% of the cases did the doctor's observations from clinical tests about the degree of drunkenness correlate with the degree of intoxication indicated by the alcohol level in the blood and/or urine. It is concluded that these results indicate that the external symptoms of alcohol intoxication vary, even when the blood alcohol concentration is high. Although the doctor's conclusions may be questionable when used as scientific evidence to estimate the degree of drunkenness, the need for a medical examination can be justified in order to discover if there was any cause other than drinking which could account for peculiar behavior and impaired driving of the suspected person.

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HS-017 884

### **ALCOHOL, DRUGS, AND DRIVING BEHAVIOUR IN SWITZERLAND**

A series of tests concerning the effect of alcohol on traffic accidents were conducted in 14 hospitals located in seven different parts of Switzerland by the Swiss Commission against Alcoholism. Of a total of 1,030 hospitalized persons injured in traffic accidents, 35.2% were found to be under the influence of alcohol, and 21.1% of the whole sample had blood alcohol

concentrations above the legal limit. The highest percentage of road accident victims who were under the influence of alcohol were found among the bicyclists and motorcyclists, followed by the motorists. The investigations showed that the ratio of alcohol to medication in road accident victims was 8 to 1. The main danger of the psychotropic drugs is not their own effects, but their intensifying effect on alcohol. While doubling the therapeutic dose of a tranquilizer does not cause a significant increase of severe driving faults, severe faults are clearly intensified by the combined effect of alcohol and drugs. Psychotropic drugs generally have an impairing effect only during the first 10 days to 2 weeks of treatment, following which driving ability can often be improved. The chief danger of the psychoactive drugs comes from the potentiating effect of alcohol on the drug.

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### **THE EFFECT OF ALCOHOL ON HUMAN INFORMATION PROCESSING RATE**

A technique of backward masking of a visual stimulus was used to give a more direct estimate of the effect of alcohol on one stage of central information processing time without confounding by sensory or motor processing delay. The effects of three dose levels of alcohol on the amount of information readout of the visual image were compared. The possibility that any change in performance could be due to an effect upon sensory input was controlled by two factors. The subjects were 12 males, aged 21 to 32 years, with 20/20 vision corrected or uncorrected. Stimuli were presented in a 3-field tachistoscope with a 91.44 centimeter viewing distance. The test stimulus card was presented in one field, the masking stimulus card in a second field, and the third field contained a card with a fixation point. The results demonstrate that the length of time available for processing the visual information storage image determined the amount of information readout. Alcohol produced a slowing of the rate at which information was read out of the sensory information storage. Only one of the subjects failed to show performance impairment under an alcohol dosage of .414 grams of alcohol per kilogram of body weight and all showed impairment with a dosage of .828 grams per kilogram of weight. There was no impairment of sensory or motor performance in this experimental situation. It is concluded that the increase in information processing time represents a danger in driving situations where a rapid response to threatening stimuli is required.

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Toronto, 1975, p399-403  
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### THE INFLUENCE OF SMALL DOSES OF ALCOHOL ON THE RATE OF DECISION MAKING

Interviews with 105 drivers who had been involved in one or more accidents while under the influence of alcohol, conducted in 1973, indicated that information overload may be a causal factor in accidents where alcohol is involved. A laboratory experiment was conducted using a computerized system in which the subjects were instructed to try to hold a small circle between two continuously moving parallel lines shown on the computer display by adapted steering movements. Three groups of 12 male university students each were used for the study, with the groups being given a placebo drink, a low alcohol dosage drink producing a blood alcohol concentration (BAC) of 24 milligrams of alcohol per 100 milliliters, or a high alcohol dosage drink producing a BAC of 57 milligrams per 100 milliliters. The computer recorded the number of times the circle touched or transgressed the limits of the road and the time during which the circle was off the road. This study seemed to yield evidence that people under the influence of alcohol doses of 60 milligrams per 100 milliliters, or even less if only the results from the older subjects are considered, become slower in handling situations that require swift changes in their response choices, as often happens in critical traffic situations.

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HS-017 887

### THE INFLUENCE OF SEX AND PERSONALITY FACTORS UPON THE EFFECTS OF TRANQUILIZERS ON DRIVING PERFORMANCE

A double-blind crossover experimental design was used to investigate the effects of sex, two personality factors (extraversion-introversion and neuroticism-stability), and four psychotropic drugs (librium, sodium amytal, stelazine, and serenace) on two driving tasks--weaving among a line of six bollards spaced six meters apart and estimating, from a distance of 25 meters, the minimum gap required between two bollards to allow the car to be driven through without touching either bollard. Eighty subjects, mostly students, were randomly assigned to one of four groups, each of which contained 10 men and 10 women, and were tested on the driving tasks after taking five doses of an active drug or five placebo tablets over a 36 hour period. Subjects were first tested sober and then tested again about one hour after taking a dose of alcohol which produced a blood alcohol concentration (BAC) of 50 to 55 milligrams per 100 milliliters of blood. The results of these tests indicate that there were no significant main drug effects or any sex or personality interactions with drug effects. Any changes in the time taken on the weaving task were not accompanied by any significant changes in accuracy and the control skills necessary to drive through the gap successfully were unaffected. For all drug groups there was a significant sex main effect, with women tending to take longer to

complete the task in every drug group. Significant drug times/sex interactions on the weaving tasks were found for sodium amytal and stelazine. There was a general overall trend for males to increase their estimation of the gap after drug ingestion, while females tended to decrease their estimates, although the only significant drug times/sex interaction found on this task was with the librium group. In all drug groups there was a significant alcohol main effect, with subjects under alcohol influence tending to increase their estimates of the gap required. Significant drug times/extraversion score interactions were found for sodium amytal, serenace, and stelazine during the weaving tasks, while only the stelazine group showed a significant drug times/extraversion score interaction on the gap estimation task. There were significant drug times/neuroticism score interactions on the weaving task with stelazine and on the gap estimation task with both stelazine and sodium amytal. It is stressed that these test results are task specific.

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HS-017 888

### THE COMBINED EFFECTS OF ALCOHOL AND COMMON PSYCHOACTIVE DRUGS: I. STUDIES ON HUMAN PURSUIT TRACKING CAPABILITY

A pursuit-tracking device was used to measure the effects of the interaction of alcohol and the following drugs on driving skills: diazepam, phenobarbital, diphenhydramine, codeine, and marihuana. The Stressalyzer device, developed by the National Research Council of Canada, is capable of detecting subtle differences in psychomotor skill resulting from the use of psychoactive drugs. This apparatus measures the following parameters of psychomotor skill: error rate; error correction time; target acquisition time; overshoot rate; settling time; and total response time. The eight male subjects used in each of the first two phases and the five male subjects used in the third phase were all between the ages of 18 and 30. All subjects were given placebo, alcohol, and alcohol plus drugs trials in a random order. Enough alcohol was administered to produce a moderate blood alcohol level, which was maintained for a period of two hours by supplemental consumption of additional alcohol. The measures taken for all drugs indicated that the peak drug effects coincided with the peak alcohol effects. Although objective impairment was observed under all drug and drug plus alcohol conditions, no important subjective impairment was reported when diazepam was added to alcohol or during the period shortly after diphenhydramine was added to alcohol. Phenobarbital and codeine produced consistent increases of perceived impairment at all time periods examined. It is concluded that the data from these tests indicate that at blood levels of ethanol below that taken by the law as presumptive evidence of impairment, meaningful additional impairment (about the amount that 0.08 grams per 100 milliliters of alcohol alone would produce) can be produced by the simultaneous use of moderate doses of the widely used drugs examined in this study. These impairments did not conform to the subjective assessments of impairment.

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HS-017 889

### THE COMBINED EFFECTS OF ALCOHOL AND COMMON PSYCHOACTIVE DRUGS: II. FIELD STUDIES WITH AN INSTRUMENTED AUTOMOBILE

The changes in driving behavior which occurred under the following drug conditions were examined: placebo; alcohol at the 0.06% level; alcohol at the 0.06% level in combination with diphenhydramine; alcohol at the 0.06% level in combination with diazepam; and alcohol at the 0.06% level in combination with marihuana. The eight subjects, six males and two females ranging in age from 19 to 27 and each having at least two years driving experience, drove a car instrumented to measure various driving parameters under various drug conditions. The instrumentation included: a potentiometer attached to the steering wheel to measure steering wheel position; a wheel counter operated by a light-interrupting mechanism in the right rear wheel to measure distance; a real time clock; and a secondary task peripheral light situated on the dash of the car and extinguished by means of a foot pedal. Analogue data were converted to digital form and then stored along with other digital data in a minicomputer located in the trunk. While driving over a 25 mile test course, the following measures of driver performance were made: steering amplitude and frequency in the 60 mph region and in the 25 mph region; speed and speed variation in both the 60 and 25 mph zones; reaction time to the peripheral light on the dash, which appeared about every 12 seconds and was to be extinguished as soon as it appeared; the number of pylons knocked down; and the distance between the front tires and the white line adjacent to the traffic signals. The results of the experiment show that alcohol alone and in combination with other drugs affects driving performance in different ways. The measures which most clearly differentiated between drug conditions were steering movement and average velocity.

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HS-017 890

### ETHANOL AND DIAZEPAM AS CAUSATIVE AGENTS IN ROAD TRAFFIC ACCIDENTS

Blood ethanol and plasma diazepam levels were determined in 74 hospitalized accident involved drivers during 1973 in Oslo, Norway. Of these drivers, 69 were male and 5 female. In addition, 204 non-accident drivers attending routine medical check-

ups were tested for blood ethanol and plasma diazepam. Although there was a marked preponderance of young drivers in the accident group (72% were 30 years old or less), no obvious age group differences were seen among the accident involved drivers with regard to occurrence of detectable blood ethanol and/or plasma diazepam. A total of 46 drivers in the accident group were found to have detectable amounts of ethanol or diazepam, or both, in their blood. Ethanol alone was found in 31 patients, with 26 of these having alcohol concentrations exceeding the legal threshold value. Diazepam alone was found in seven patients, with four of these having plasma concentrations exceeding the upper limit of adopted therapeutic range and with six having concentrations considered sufficiently high to impair their driving ability. The combination of diazepam and ethanol was found in eight of the accident involved drivers, with all of these having alcohol concentrations exceeding the legal limit. It is suggested that these data indicate that alcohol and diazepam, either alone or in combination, may have been a causative factor in 54% of the 74 traffic accidents involved in this study. No significant difference was found between motorcycle drivers and drivers of cars with regard to the use of ethanol and/or diazepam prior to the accident. Only 2.0% of the reference group in the study showed blood ethanol and/or plasma diazepam concentrations sufficiently high to impair driving ability.

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### DRUG AFTER EFFECTS AND TRAFFIC SAFETY

The effects of alcohol and other drugs on behavior which persist after the drug has been eliminated from the body and the role of these after effects in traffic accidents are discussed. Drugs may produce three main disturbances which persist after the drug has disappeared from the body: the withdrawal phenomenon, which varies from chemically important to barely detectable by sophisticated technology; after affects involving flashbacks, which may occur with LSD and other hallucinogenics; and more permanent brain damage, which may vary in intensity from dramatic brain shrinkage to an "amotivational syndrome". This last category of disturbances may also result from the insidious effects of environmental and industrial chemicals. An educational program for clinicians, manufacturers, and the public might increase the awareness that the period of risk in drug use extends beyond the duration of the drugs in the body and that behavior should be governed accordingly. It is suggested that some consideration should be given as to whether the chronic drug or alcohol user should be denied the right to drive at all or at least have that right restricted in some way.

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HS-017 892

**INTERACTIONS OF SOME STREET DRUGS**

The interactions of ethanol and barbiturates (thiopental, pentobarbital, amobarbital, phenobarbital, and barbitol) were investigated using male albino rats of the Wistar strain. Male Swiss Webster mice were used to investigate the effect of ethanol on the toxicity and metabolism of amphetamines. Rats were used to test the effect of ethanol on the pharmacokinetics of diazepam, the effect of ethanol on the metabolism of isoniazid, the effect of ethanol on the metabolism of tetrahydrocannabinol, and the effect of cannabinoids on the 0in-vivo' metabolism of pentobarbital. It would appear from these investigations that the metabolism of many drugs may be altered by the presence of ethanol, leading to an enhancement of the pharmacological effects and the increased likelihood of toxic reactions. The studies with animals suggest that the retardation of the clearance of some drugs from blood due to the presence of ethanol most likely is due to an inhibition of drug metabolism by ethanol. This inhibition leads to higher brain levels of the drug and enhanced effects on the target organs, such as the central nervous system. Investigations of the 0in-vivo' interaction of marihuana components with pentobarbital indicate that non-euphoric effects, due to cannabinoids other than tetrahydrocannabinol, which might lead to impairment of function, are a distinct possibility.

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HS-017 893

**THE INTERACTION OF ALCOHOL AND DELTA 9-TETRAHYDROCANNABINOL IN MAN: EFFECTS ON PSYCHOMOTOR SKILLS RELATED TO DRIVING**

The effects of a single moderate dose of tetrahydrocannabinol (THC) upon the impairment induced by a similarly moderate dose of ethanol was investigated using 12 healthy, paid, student volunteers (eight males and four females) between the ages of 18 and 29 years. Subjects (all with previous cannabis experience) were tested under each of the following conditions: ethanol plus THC; ethanol plus THC placebo; THC plus ethanol placebo; and THC placebo plus ethanol placebo. The tests administered measured standing steadiness, manual dexterity, numerical reasoning, perceptual speed, and simple and complex reaction times. The group which received both ethanol and THC had higher blood alcohol levels than that which received ethanol alone, with the difference being significant at 40 minutes after consumption. At the dose level employed (0.54 grams per kilogram body weight), ethanol alone did not induce significant decrements in performance on any of the tests. The THC dosage (about 10 milligrams per 70 kilograms body weight) was also without significant effect in most of the tests, although there was a slight increase in the number of errors made in the perceptual speed and Vienna Determination Apparatus tests. A combination of THC and ethanol did produce changes in several of the tests which were significantly different from both the placebo group results and the results from groups receiving either drug alone. The combina-

tion produced an increase in errors, but not in performance, in the numerical reasoning and perceptual speed tests and also on the Vienna Determination Apparatus. The test results indicate that an interaction between ethanol and THC exists and that this interaction is at least additive.

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HS-017 894

**RELIABILITY AND SIGNIFICANCE OF RESULTS OF ALCOHOL AND DRUG ANALYSES**

Problems involved in the analysis of alcohol and drugs in body fluids are examined. The two main methods used extensively for identification of alcohol and drugs present in body fluids are those based on spectroscopic methods and those based on chromatographic parameters. Each of these methods, while generally resulting in correct identification with skilled interpretation of results, are unable to distinguish between certain drugs. The well-tried methods of identifying alcohol are fully satisfactory. The most common method for determining how much of the drug is present in a particular biological fluid is to first isolate the drug and then use the preferential solubility of the drug in an organic solvent. Evaporation of the solvent, coupled with selective use of acids and bases, can provide a reasonably pure extract which can then be investigated by chromatography. Both the accuracy and the precision of the methods used for measuring drug levels are important for proper analysis. Analytic techniques must have a high degree of specificity to exclude potential interfering compounds. The accuracy and precision that can be obtained in any particular laboratory depend on the substance to be analyzed, the techniques used, and the in-built tests that are performed in a particular laboratory. Although 100% accuracy and precisions of 1 to 2% can be maintained in a national system for alcohol, these conditions do not apply to drugs. The analysis for drugs in urine and blood is in general a highly complex procedure, more difficult and complex than those used for alcohol, and it is not usually necessary to achieve a high degree of precision. Although it is now possible to determine the probable amount of alcohol in the body at the time a sample is taken, drugs are available in a number of forms which may behave in radically different manners in the body. Drugs may become localized in one particular center in the body, creating a situation in which there are massive amounts of the drug in the body, but only minute amounts in the blood stream or urine.

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HS-017 895

**RECENT DEVELOPMENTS IN BREATH-ALCOHOL ANALYSIS**

Developments in breath-alcohol analysis during the period since the Fifth International Conference on Alcohol and Traffic Safety (Freiburg, Germany, September 1969) are reviewed. Major emphasis has been on instrumentation utilizing physical, physical-chemical, and other "wet-chemistry" principles and approaches. Technologies in breath-alcohol analysis which have become popular during this period include: electrochemical oxidation; fuel cell catalysis; infrared photometry; and MOS gas-sensing. Quantitative evidential devices which have been developed since 1969 include: the Alcoholic Detector; Alco-Limiter; Breathalyzer, Model 1000; and Intoxilizer. New screening test devices include: Alco-Sensor; A.L.E.R.T.; and Alveolar Air Breath-Alcohol System. New accessories and collection devices include: Alco-Analyzer Digital Readout; Breathalyzer Transfer Unit; GC Intoximeter Digital Readout; Nalco Alcohol Standard Simulator; Standard Alcohol Sample; Breathalyzer Collection Unit; Sober-Meter SM-7; and Vacu-Sampler. These new instruments and devices have achieved substantial sophistication, especially with respect to alcohol detection and quantitation, and a considerably lesser degree of adequacy and sophistication in regard to breath sampling and other biological aspects. The trend in newly developed devices has been markedly toward self-contained electrically-powered instruments utilizing physical-chemical principles. There has also been a significant increase in the number and variety of prototype devices and instruments for breath-alcohol analysis which have been developed to the pre-production stage, but have not been produced or marketed. Some results from in-vivo and in-vitro testing of new devices are presented.

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1975 ; 26refs  
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HS-017 896

**ASPECTS OF DRUG ANALYSES IN RELATION TO ROAD TRAFFIC LEGISLATION AND SUPERVISION**

Methods used to deal with alcohol and drugs in relation to traffic safety in Sweden are discussed. Sweden has had legislation concerning drinking-driving since 1923. It is now a criminal liability to drive under the influence of alcohol or other intoxicants if a blood alcohol concentration (BAC) or other drug concentration is sufficiently high that the operator is judged to be incapable of safe driving. In Sweden, doctors are obliged to inform patients about the possible traffic risks resulting from the medications they prescribe. If a person is injured and brought to a hospital, police can ask for a blood sample only if they suspect that the driver is drunk or intoxicated by drugs. Before a prosecutor can obtain a conviction, it must be proved that the driving concerned was somehow a hazard to traffic and that the operator took some substance that made him unfit for driving. Evidence presented by a doctor in court is probably more important than drug analyses. Blood samples are not analyzed for other drugs if a reasonably high BAC is found. It is suggested that research be conducted

on the effect of alcohol and drugs separately and in combination using persons with a high tolerance to both. The dangers of alcohol and other drugs with respect to traffic safety are taught in schools and in the course which must be taken in order to obtain a driver's license. Motor vehicle, injury/fatality, sampling, and detected drug use statistics for Sweden are presented.

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1975 ; 2refs  
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HS-017 897

**A HISTORICAL AND EXPERIMENTAL STUDY OF THE BREATH/BLOOD ALCOHOL RATIO**

Although breath alcohol analysis has been used for the determination of blood alcohol concentration (BAC) for more than 40 years, the relationship between the breath and blood alcohol concentrations is still uncertain. While the blood alcohol level is now almost universally accepted as a reliable indicator of intoxication, breath is still frequently regarded as only suitable for a screening test. A historical survey of breath alcohol analysis shows that there have been good reasons to doubt the validity of BAC estimates obtained by breath analysis, and that, in the early years, its reliability was considerably overestimated. However, recent studies have indicated that the determination of the BAC from breath is now possible with a precision and accuracy which, though not quite as good as obtained with direct blood analysis in the laboratory, are quite adequate for practical purposes. A re-examination of the theoretical and practical basis of the determination of blood alcohol by breath analysis included in-vitro studies of the air/blood ratio and in-vivo studies of breath/blood ratio. An observation of the difference in the in-vitro ratio between men and women shows that variations in haematocrit must contribute to variations in the breath/blood ratio in-vivo because the alcohol in the breath is derived from blood by equilibration, while blood analysis is normally on a weight/volume or volume/volume basis. Where there is a discrepancy between breath and blood from this cause, the breath estimate is to be preferred as it depends on the partial pressure of alcohol in the tissues which presumably controls its effect on the brain. This source of error could be eliminated if breath analysis were carried out by direct head space chromatography on whole blood. These studies indicate that the best estimate of the breath/blood ratio is 1 to 2,300 and that the variability of the ratio is substantially greater than can be accounted for by the analytical errors of breath and blood analysis. The breath/blood ratio can sometimes change without any change in breath concentration and individual variations in the stability of the breath concentration can occur.

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HS-017 898

**ERRORS IN CURRENT ALCOHOL BREATH ANALYSIS**

Tests were conducted using the Model 1000 Breathalyzer to determine how closely the blood alcohol concentration (BAC) established via a breath test correlated with the BAC determined via a blood sample. The Breathalyzers used in these experiments were examined for accuracy by the Illinois Department of Public Health and each examination showed that the instrument was properly calibrated and usable under the criteria given in the Illinois Implied Consent legislation, which establishes a BAC of 100 milligrams of ethanol per 100 milliliters of blood or higher as proof of driving under the influence of alcohol. Although the Breathalyzer requires a minimum of 452.5 milliliters of lung air from a subject to advance the instrument to the analysis stage where the last 52.2 milliliters of expired air is automatically analyzed for alcohol content, this minimum amount of air will not give an accurate reading indicative of the actual BAC of the person being tested. Minimum and maximum breath sample readings taken 6 minutes apart were compared to corresponding blood sample readings before and after the Breathalyzer was modified to proceed to analysis after a lung air volume of 600 milliliters instead of 452.5 milliliters. The test results show that a 49% error in determining the actual BAC can be expected when using the minimum breath sample on the current Breathalyzer in Illinois. Modification of the intake controls to ensure a 600 milliliter minimum breath sample reduced the expected error from 49% to 34% when analyzing a minimum breath sample. A determined effort to obtain a maximum breath sample ensures close correlation with the actual BAC (about 10 to 20% below the BAC), using either the modified or unmodified Breathalyzer.

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HS-017 899

**THE RANGE OF CONCENTRATIONS OF FREE ACETONE IN THE PLASMA AND BREATH OF DIABETICS AND SOME OBSERVATIONS ON ITS PLASMA/BREATH RATIO**

By use of headspace analysis employing the "Diet Monitor", the normal range of plasma acetone concentrations in subjects free from metabolic disease has been confirmed. In 55 ambulatory diabetic subjects, only two were found to have plasma acetone concentrations in excess of 5 milligrams per 100 milliliters. In 25 specimens from hospitalized subjects having plasma sugar concentrations in excess of 300 milligrams per 100 milliliters, only one had an acetone concentration greater than 5.0 milligrams per 100 milliliters. Preliminary estimates of the plasma/breath ratio for acetone on blood bank plasma gave an average value of 309 at 34.5 degrees C. The value for normal plasma appears to be a little larger. The temperature coefficient for the vapor concentration of acetone in plasma in the neighborhood of 34.5 degrees C is about 3.5% per degree of temperature change. These data should eventually permit esti-

mation of the degree and frequency of concentrations of acetone in the breath of ambulatory subjects that might cause significantly false high values to be obtained for ethanol by use of breath-testing instruments employing oxidative reactions or infrared absorbance rather than gas chromatography.

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HS-017 900

**THE ADVANTAGES OF AUTOMATED BLOOD ALCOHOL DETERMINATION BY HEAD SPACE ANALYSIS**

The gas chromatographic (GC) determination of blood alcohol is the only routine procedure that enables ethanol to be specifically determined in biological materials and at the same time permits the determination of other volatile components. In routine operation, direct manual injection of the samples, even when the blood samples have been diluted, is not easy to carry out continuously. For this reason, mechanized procedures are to be preferred, particularly the head space technique. The ideal introduction of the sample in gas form produces sharp peaks, high separation performance, and a stable base line on the chromatogram. The use of column fillings having carbon as the support material and coated with polyethylene glycol 1500 brings about an excellent separating performance and enables the analysis time to be reduced. By selecting a relatively low column temperature, all substances of interest can be separated in a relatively short time. For quantitative determinations, an internal standard is absolutely necessary to maintain high accuracy and to carry out a continuous check on the functioning of the instrument. Tertiarybutanol has been chosen for this purpose. Quantitative determination is carried out by determining the ratio of alcohol to internal standard. The internal standard can also be used for the determination of other volatile substances. With the automated head space procedure, the relative standard deviation for a single sample employing an internal standard is plus or minus 0.5%, while for alcohol alone a value of plus or minus 0.7% can be obtained. The deviation of the single values, calculated from double determination on 2,000 random samples, is plus or minus 4.3%. It is concluded that at the present stage of development of instrumental analysis, the GC head space technique is the optimum method for the determination of the blood alcohol concentration.

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HS-017 901

### A COMPARISON BETWEEN THE GAS CHROMATOGRAPH INTOXIMETER AND A DIRECT BLOOD ANALYSIS

The reliability of breath alcohol analysis for determination of the blood alcohol level (BAL) depends on the analytical reliability of the breath alcohol analysis itself and on the constant factor used for conversion of the breath alcohol concentration to blood alcohol concentration. The accuracy of the Gas Chromatograph Intoximeter (GCI) in determining BAL was measured using breath samples from 206 subjects and comparing the BAL's obtained in this manner with direct blood analysis results for the same subjects. Two types of accuracy were evaluated: experimental accuracy, where GCI results were compared to their respective BAL, and predictive accuracy, where the BAL was estimated by the GCI results. The GCI demonstrated a high level of experimental accuracy and predictive accuracy. The GCI averaged 0.013% lower than a direct blood analysis with a standard deviation of 0.014. About 90% of the results showed a GCI result equal to or less than its corresponding BAL, suggesting that the alcohol distribution ratio of 1 to 2,100 may be too low. An increasing deviation between the GCI result and its corresponding BAL as the blood alcohol level increases indicates that there is an incorrect value for the 1 to 2,100 ratio.

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HS-017 902

### COMPARISON OF BLOOD AND BREATH TESTING UNDER FIELD CONDITIONS

The Institute for Road Safety Research examined the following nine breath analyzing instruments based on four types of analytical principles: dry chemical--Kitagawa Wright; wet chemical--Ethanographe, Alcolinger Automatic, and Breathalyzer 1000; infra-red light absorption--Intoxilyzer; and fuel cell--Alco-limiter, Alcohol Screening Device, Alcolmeter (bench), and Alcolmeter (pocket). Both breath tests and blood sampling were carried out at the roadside on randomly selected motorists, but the actual blood analysis was conducted in the laboratory. The roadside tests were combined with surveys on drinking and driving habits which were carried out in 1970, 1971, and 1973 during weekend evenings. Repeated analysis in the laboratory of a standard air/alcohol mixture corresponding to a blood alcohol concentration (BAC) of about 100 milligrams per 100 milliliters showed that the maximum deviation was less than 5 milligrams per 100 milliliters for all instruments. The manner in which the breath sample was taken was found to differ considerably from instrument to instrument and in some cases differed considerably from the factory specifications. All the instruments except the Breathalyzer 1000 and the Intoxilyzer showed faults during the roadside tests. Possible causes for differences between instruments with regard to precision in breath sampling and accuracy include the analytical principle used, the precision of the measurement, stability of calibration and zero-setting, sensitivity

to extraneous factors, and breath sampling and physiological variability in the ratio between alcohol content of breath and blood. The laboratory tests showed only minor differences in precision of results when standard air/alcohol mixtures were analyzed. The calibration of all fuel cell instruments was found to be less stable than the rest of the instruments. The test results generally confirmed that the larger the expired volume of breath before sampling for analysis, the more accurate the prediction of the blood test is. It hardly mattered if the blood test was predicted by one or the average result of two successive breath tests, as long as the same instrument was used, indicating that lack of accuracy is a systematic error per test subject. The Intoxilyzer was found to be the best for accuracy and to be only slightly less precise than the blood test.

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HS-017 903

### BREATH ALCOHOL ANALYSIS BY GAS CHROMATOGRAPHY: TWO YEARS' EXPERIENCE WITH FIELD COLLECTED SAMPLES

An evaluation of a breath testing system utilizing the Gas Chromatographic Intoximeter and crimper boxes manufactured by Forrester's Intoximeters Incorporated was conducted in Vermont in 1972 and 1973. The breath samples used in the study were all law enforcement samples collected in the field by means of a crimper box by a trained, full-time law officer. Of the 3,438 breath samples collected and analyzed, 268 were not used as prosecution evidence because of gross sampling errors. The portability of the remote field collecting devices used in the GCI system makes the system particularly suited to use in rural areas with a widely dispersed drinking-driver population. While the use of a central location for the analysis of samples eases logistics problems and improves communication of the results of the tests, it does result in a 3 to 4 day delay in getting test results to the police officer who collected the sample. Statistical analysis of breath sample segments simultaneously collected showed an error of plus or minus 13% at the 95% confidence levels. In Vermont, which observes a statutory blood alcohol concentration (BAC) of 0.01 grams per 100 milliliters, this means essentially that BAC levels of less than 0.13 should be prosecuted with caution and preferably along with other evidentiary material. While the number of persons prosecuted for driving while under the influence of alcohol more than doubled in 1972-1973, the conviction rate remained at about 80%. However, the average chemical test result has dropped from 0.215 grams per 100 milliliters to 0.147 grams per 100 milliliters, indicating that law officers in Vermont are now apprehending, arresting, and testing out drinking drivers with a greater awareness of the proper selection criteria and an appreciation of the gravity of the problem.

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HS-017 904

# **PRACTICAL SCIENTIFIC PROBLEMS ASSOCIATED WITH DRINKING AND DRIVING LEGISLATION IN ENGLAND**

The Road Safety Act 1967 which became effective in Great Britain in October 1967 introduced blood or urine alcohol concentration as the basis of an offence for driving while under the influence, replacing the then current subjective assessment of the driver's clinical condition. Although the offence was defined in scientific terms, arguments over scientific details resulted from the fact that there was neither evaluation of the containers that were used nor any data pertaining to the influence of conditions of storage of specimens before analysis at the time of implementation. A gas chromatographic method of analysis of the small volume blood samples has been used in most laboratories and has proved most satisfactory. However, the small polypropylene pots used at first to store blood samples have been replaced with glass vials due to a persistent problem with the occurrence of clotted blood samples. The new containers consist of 5 milliliter capacity glass vials with a vaccine bottle type of closure. The law provides that a driver is guilty of driving under the influence if the alcohol concentration in the second of two urine specimens provided within an hour exceeds the permitted level of 107 milligrams per 100 milliliters. The use of the second sample for analysis ensures that the sample will contain alcohol in proportion to that currently circulating in the blood. It is possible that there may be some loss of alcohol from the screw-capped glass bottles and plastic tubes now used for storage of the samples. In most cases two positive breath tests using Alcotest 80 tubes are given by the motorist before a blood or urine sample is provided. That there are problems with the breath analyzing system is indicated by the fact that in several cases the blood samples, which are mostly taken within an hour of a positive breath test, are found to contain much less than the legal limit on subsequent analysis.

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HS-017 905

# **ALCOHOL CONCENTRATION IN URINE AND ITS FORENSIC EVIDENCE**

Research was conducted, using human subjects, on: the trend of ureteral urine alcohol concentration; the relationship between ureteral urine, vesical urine, and blood alcohol; the equilibrium between blood, serum, and urine by constant

blood alcohol concentration; and the permeability of the bladder for alcohol. Because of physiological conditions, the urine alcohol concentration depends upon the following: the quantity of blood alcohol concentration; the amount of alcohol concentration in the ureteral urine; diuresis; the time between mictions; and the permeability of the bladder for alcohol. The rising ureteral urine alcohol curvature was found to follow the blood alcohol and serum alcohol curve by about 10 minutes. The vesical alcohol concentration compared to the blood alcohol concentration curve reflected a difference of half an hour. Experiments on diffusion showed that the equilibrium concentration between serum and urine was 1 to 1.07, depending on the amount of protein in the serum. The change of alcohol concentration in the bladder and ureter is influenced by the periods between mictions. The longer these periods are, the more likely there will be differences between ureteral urine and vesical urine alcohol. The concentration of vesical urine was found to be determined by diuresis. The permeability of the human bladder for ethyl alcohol has no effect on the alcohol concentration in vesical urine, even after the urine has settled over a period of several hours in the bladder. The variation of the quotient urine alcohol concentration/blood alcohol concentration is very high, and under practical conditions it is impossible to determine the true blood alcohol concentration from the result of the determination of alcohol concentration in urine samples.

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HS-017 906

# **THE HAMBURG, W. GERMANY, 1973 REPORT QUESTIONING THE RELIABILITY OF BREATH ALCOHOL INSTRUMENTS FOR MEDICOLEGAL USE IN TRAFFIC CASES**

A report on the reliability of breath alcohol instruments for medicolegal use in traffic cases prepared by Hamburg, West Germany, senate commission in 1973 is discussed. Breath alcohol instruments and devices investigated by the commission included: a new model of the Grosskopf Alcotest screening detector tubes; the Ethanographe, or Alcolinger Automatic; and the gas chromatograph Intoximeter (GCI). The chief objection of the commission to the use of breath analyses in West German traffic cases is that, during the period of rising blood alcohol concentration (BAC), the breath instrument reading is frequently much above the BAC in the cubital vein. Although the commission apparently would accept a maximum divergence of plus or minus 10% between the breath instrument reading and the result of direct blood analysis, a study conducted using the GCI indicated that this requirement was met in only about two-thirds of the breath/blood pairs. Breath samples cannot be stored and cannot be taken without the cooperation of the subject. The commission concluded that there appear to be no scientific grounds for recommending that breath alcohol procedures should replace the official blood alcohol testing program or even be used for screening purposes. It is suggested that the commission conduct further investigations into other available breath analysis instruments and that they should use either arterial blood or fingertip blood



rather than cubital vein blood during rising BAC, since the cubital vein blood is very unreliable in determining intoxication under rising BAC conditions. The use of rebreathed air for breath analysis should also be investigated.

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HS-017 907

### INVOLVEMENT OF ALCOHOL, CARBON MONOXIDE AND OTHER DRUGS IN TRAFFIC FATALITIES

The results of a three-year study of the involvement of drugs and carbon monoxide in automobile operators and pedestrians killed in six counties of North Carolina are discussed. Blood, liver, and urine samples from a total of 251 fatalities were examined for the presence of drugs and carbon monoxide. The major drug which was detected in the samples from drivers involved in single-car crashes was ethyl alcohol; in cases where another drug was involved, alcohol was also present. Microscopic examinations of the livers of 63 of the 72 driver-victims of single-car crashes showed that 29 had changes highly indicative of chronic alcohol abuse, with an additional five of the 63 showing equivocal results. Ethyl alcohol was also the drug most frequently found in the operator-victims of multiple-car accidents. In this group, drugs alone and in conjunction with alcohol were also found. The livers of 43 of the 99 drivers in this group showed changes indicative of chronic alcohol abuse. Alcohol alone was detected in the blood of half of the 62 pedestrian fatalities and another 8% had other drugs alone or in combination with alcohol. Of the pedestrians, 25 had liver changes suggestive of chronic alcohol abuse. Significant amounts of carbon monoxide were found in the blood of three crash fatalities. The blood of samples of the pedestrians has a higher positive mean alcohol concentration than that of the single-car operators or that of the multiple-car crash operators. Alcohol was found in blood samples from 92% of the operators in single-car crashes, 82% of the operators in multiple-car crashes, and 86% of the pedestrian fatalities. Drugs other than alcohol most frequently encountered were the sedative hypnotics, the analgesics, the antiepileptic drug diphenylhydantoin, the antiarrhythmic drug quinidine, and quinine.

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HS-017 908

### "WILL THE REAL DRUGGED DRIVER PLEASE STAND UP?" AN ANALYTICAL TOXICOLOGY ASSESSMENT OF DRUGS AND DRIVING

Although the laboratory tools and the social justifications are now available to study and identify drugged drivers, it is suggested that the time, labor, and money necessary for such a program cannot be justified in terms of possible benefits to future traffic safety. Much of the known drug use problem occurs in drinking drivers, and a great variety of commonly prescribed and over-the-counter drugs in combination with alcohol do potentially constitute a major traffic safety problem. However, a broad research study involving comprehensive toxicological analysis of biological samples from drivers, which includes selected demographic areas of the country, is needed to realistically determine if a significant problem exists. Problems such as sample choice, analytical difficulties, and preliminary inferences from the analytical results, as well as pharmacological and physiological qualifications and complexities, render interpretation of 'under the influence of drugs' in any strict scientific sense impractical. Other problems include the importance of dosage, the time interval between dose and sample, the pharmacodynamics of the drug, and the subjects possible tolerance, hypersensitivity, and metabolism. It is suggested that the major need in the area of control of the use of drugs by drivers is for the general driving public to recognize the risks associated with uncontrolled drug use, particularly in conjunction with alcohol, so that they have a basis for personal decision.

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1975 ; 8refs

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HS-017 909

### IMMUNOASSAYS FOR THE DETECTION OF DRUGS IN DRIVERS

Procedures currently available for use in the detection of drugs in biological fluids include: gas-liquid chromatography; thin-layer chromatography; fluorometry; and spectrometry. Due to the fact that many drugs are effective in small amounts, sensitive analytical techniques must be used. Immunoassay of drugs is sensitive, reliable, and can provide the means for handling extremely large volumes of samples at a very nominal cost. This technique is based on the binding of a specific drug by an antibody. The antibodies must be produced, generally by attaching the drug of interest to a protein and injecting it into an animal which will produce antibodies directed against various portions of the drug-protein complex and reasonably specific for the drug of interest. These antibodies are separated from the animal's serum and used to assay for the drug. The immunoassay is highly sensitive and has great specificity, making it possible to use this process without the usual extraction and concentration steps generally needed for analysis. Immunological assay systems now available for drugs of abuse include: Free Radical Assay Technique; Enzyme Multiplied Immunoassay Technique; Radioimmunoassay; and Hemagglutination Inhibition. Each

system has its own advantages and limitations, and the particular method best suited for application in any particular institution must be determined by the number of samples to be analyzed per day, the sensitivity and accuracy needed, the turn-around time required, and the amount of money available for hardware and reagents. Although immunoassays produce very few false negative results, positive results must be confirmed by some other procedure.

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1975 ; 8refs  
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HS-017 910

#### **A SYSTEM FOR BREATH ALCOHOL ANALYSIS, AND A SYSTEM TO COLLECT AND PRESERVE BREATH EVIDENCE OF BLOOD INTOXICANTS**

The Co-Sweep Preservial collection and preservation systems have been developed by Omicron Systems Corporation, of Palo Alto, California, for sampling and evidence retention of breath volatile intoxicants in drunken driving cases. The Preservial provides an inexpensive, simple to use, self-sealing system for breath analysis consisting of an optically clear seal flange glass vial, a teflon-lined rubber septum, and an aluminum sealing ring or screw cap. The Co-Sweep Preservial is used to collect, concentrate, and preserve intoxicants such as alcohol, acetone, and the cannabinoids from breath samples. This system has a dynamic concentrating feature, a small containment area, and minimal analysis preparation. The Co-Sweep Preservials are designed for direct use in spectrophotometry or for analysis that uses virtually any laboratory technique or instrument. The system is still under study to determine the correct flow rates, sample size, correlations or recovery rates, and storageability.

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HS-017 911

#### **A SIMPLE METHOD FOR THE DETERMINATION OF THE SMOKING OF MARIJUANA**

A simple, rapid, inexpensive method for the determination of the smoking of marijuana is presented. The method of collection, which involves the scrubbing of lips and fingers with a swab dampened with isopropyl alcohol, is simple enough for collection in the field by law enforcement agencies. The method of analysis, thin layer chromatography (TLC), is simple enough to be conducted in most laboratories. Tests conducted on 20 deceased individuals suspected of marijuana use showed that the body areas giving the best response by TLC were the upper lips and the thumb and forefinger of the domi-

nant hand. The technique was found to be sensitive down to 0.5 micrograms of delta nine tetrahydrocannabinol. Tests conducted with volunteers who had smoked one gram of "good grass" showed that positive results with this procedure were obtained only during the immediate period after smoking and up to a 6 hour interval.

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HS-017 912

#### **QUALITY CONTROL IN A TOXICOLOGY LABORATORY**

Problems of quality control related to qualitative and quantitative analysis in a toxicology laboratory are discussed. The Center for Disease Control in Atlanta, Georgia, developed a quality control program for on the spot checks designed to determine if there was a problem with the operator, with a particular drug, or with the thin layer chromatography operating conditions used for drug analysis. With about every 10 patient urine samples, one spiked urine control was processed. On every thin layer plate there was a known aqueous standard and a urine control spotted. Both unknown and blind controls were also processed as patient samples. The most common errors identified by this procedure were: changed thin layer spotting techniques; errors in the detection of morphine; incorrectly prepared solvents; solvent tanks that were left open; poor quality of reagents; and insufficient time lapse between sprays. By allowing the thin layer plate to be left for about an hour after spraying with acidic iodoplatinate before interpretation, the percentage accuracy in the identification of morphine was improved from 89% to 96%. For quality control in quantitative analysis using the gas chromatography (GC) technique, both the GC conditions and operator techniques should be monitored. By processing standards, quality control sera, and split samples, it is possible to monitor the extraction and quantitation, tabulation of results, and the operator and the operator's techniques. This program allows interjection wherever action is necessary. The errors corrected in this manner at the Center for Disease Control were: inconsistency in extraction methods; mis-identification; and calculation errors. A sequential reporting form using the initial results of the patient as a control makes the analyst immediately aware of any changes and allows immediate investigation of any sudden change in results from positive to negative or vice versa.

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1975 ; 4refs  
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### CROSS-NATIONAL COMPARISONS OF DRINKING DRIVING LAWS

A review of legislation in several European countries with regard to drinking and driving is presented. The existence and nature of the laws concerned, the means available for the enforcement of the laws, and the provisions for handling of drivers convicted under the legislation are discussed. Nearly every European country has introduced a specific offence for driving under the influence of alcohol. Blood alcohol concentration (BAC) may be incorporated as a constituent element of the substantive law or may simply be used to provide evidence of impairment under procedural law along with other evidence. Problems with enforcement include: the provision of samples for the courts; screening procedures; and provisions for immunity if the driver is admitted to a hospital. The three main penalties attached to the offence of driving while impaired by alcohol are imprisonment, fines, and disqualification from driving by suspension of the driving license. Penalties may be graded according to the severity of the offence or to the history of previous offences. Evaluation of drinking driver countermeasures may involve time-series studies on casualty savings, comparison of the distribution of BAC among drivers before and after the introduction of control legislation, and observation of the immediate reaction to legislation. It is concluded that effective legislation should include: provision for drivers to be required to take a screening breath test regardless of signs of alcoholic intoxication; provisions for spot checking of drivers for BAC; follow-up blood samples when screening tests are positive; definition of BAC in excess of a statutory limit as a separate offence with mandatory conviction on proof of BAC in excess of the limit; mandatory suspension of the driving license for a period of at least one year on conviction and provisions for medical treatment of alcoholic conditions; and collection of adequate baseline data before the introduction of any changes in legislation so that the effects of the changes can be evaluated.

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### PROBLEMS OF ENFORCEMENT, ADJUDICATION AND SANCTIONING

The enforcement of laws related to the problem of drinking drivers, including apprehension of violators by the police, adjudication by the courts or other institutions, and the imposition of sanctions, is discussed. About 10% of police resources are allocated to traffic law enforcement in the typical American city, but these police are engaged in the enforcement of a wide range of traffic violations, including such offences as parking violations. Police officers in a position to make traffic violation arrests make on the average two alcohol related traffic arrests each year. The results of roadside surveys of alcohol in the driving public indicate that with this level of arrests there are about 2,000 violations of drinking driving laws per arrest. Interviews with a group of police officers indicated

that, while each had made between zero and three alcohol related traffic arrests during the prior year, the numbers each officer had stopped for hazardous moving violations whom they thought should have been tested for blood alcohol concentration ranged from 75 to 100. Reasons for this exercise of police discretion include: cynicism as to the support the charge of driving under the influence will receive in the courts; empathy with the driver; a feeling that the sanctions are too severe; and the cumbersome system used to handle these offenders. Even in the most ambitious programs, enforcement of drinking driving laws is at a minimal level. It is suggested that an optimal program for the enforcement of these laws might involve periodic intense enforcement efforts instead of a constant level of effort. In addition, the deterrent effect of the enforcement of drinking driving laws should be viewed as a primary means of reducing driving while impaired by alcohol and of identifying problem drinkers.

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1975 ; 10refs  
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### THE EFFECTIVENESS OF DRINKING-AND-DRIVING LAWS IN SWEDEN AND GREAT BRITAIN

The development of the legal response to the problem of the drinking driver, from lack of awareness, through the enactment of classical laws, to the relatively recent *Oper se'* or fixed blood alcohol concentration (BAC) laws in Sweden and Great Britain is examined. While classical laws generally simply made it an offence to drive while under the influence of alcohol, *Oper se'* laws define the prohibited behavior in terms of maximum BAC limits. Sweden first adopted a *Oper se'* law in 1941, while Great Britain adopted such legislation in 1967. The British Road Safety Act of 1967 resulted in a sharp drop in highway casualties, although this effect may be only temporary. In Sweden, important changes in drinking driving laws included: 1934, when blood tests were incorporated into the law and prison was established as a routine punishment; 1941, when the *Oper se'* legislation was enacted; and 1957, when the *Oper se'* limit was lowered from 0.8 to 0.5 pro mille. However, there is no objective evidence that Swedish laws deterred drinking drivers, even though the violation carries the serious penalty of a prison sentence in addition to lengthy license suspensions. It is suggested that the key to the success of the British law was the government's success in convincing British drivers in 1967 that there was a significant risk of apprehension by the police for drivers who drank more than the permissible amount of alcohol. As the public learns that the risk of apprehension is in fact quite minute, the effect of the legislation on alcohol-related traffic casualties is decreasing. It may be that the Swedish government was never able to produce a credible threat of apprehension; most arrests at present for drinking and driving appear to occur as the result of accidents. Various fatality-year graphs are provided.

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Toronto, 1975, p663-78  
1975 ; 26refs  
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grant from the Insurance Inst. for Hwy. Safety, Washington,  
D.C. Paper from the Proceedings of the International  
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HS-017 916

### THE CANADIAN BREATHALYZER LEGISLATION: AN INFERENTIAL EVALUATION

The effect of the Criminal Law Amendment Act, or Breathalyzer Legislation, which came into force in December, 1969, on serious road accidents in Canada is evaluated. This law made it an offence for a driver to have a blood alcohol concentration (BAC) over 0.08% and gave police power to demand that a driver suspected of alcohol impairment take a breath test. Reported fatal accidents decreased 6.3% during the first full year of the legislation, from 4,549 in 1969 to 4,264 in 1970. This drop was greater than that in any previous year, but was followed by a general increase in 1971. The percentages of fatal accidents occurring at night and on weekends each decreased about 2% in 1970. Data from provinces which keep records on the presence of alcohol in the bodies of drivers fatally injured in traffic accidents showed that the percentage of drivers with a BAC of at least .10% was only marginally below the average for the previous four years. As a result of the legislation, police were more likely to require a driver to take a breath test, since the results of this test alone were sufficient to prove impairment. Previously, breath test results had to be corroborated by physically observed symptoms to obtain a conviction. Impaired driving charges increased substantially across Canada in 1970, nearly doubling in some provinces. However, the evidence to date demonstrates convincingly that the Breathalyzer Legislation did not have a large or sustained effect in Canada. It is suggested that this failure may be due to a lack of perception of the risk of apprehension on the part of potentially impaired drivers resulting from the fact that the police officer must have reasonable grounds to suspect impairment and cannot require a screening test. Fatal accidents (1969, 1970, 1971) are tabulated by province and comparisons of traffic injuries and fatalities for Canada and England are provided.

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Toronto, 1975, p679-87  
1975 ; 9refs  
Extracted from a Ministry of Transport report by Carr, B. R.,  
Goldberg, H. and Farbar, C. M. L., The Breathalyzer  
Legislation: An Inferential Evaluation, Transport Canada,  
Ottawa, Ont., Canada, 1974. Paper from the Proceedings of  
the International Conference (6th) held in Toronto, 8-13 Sep  
1974.  
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HS-017 917

### THE EPIDEMIOLOGY OF TRAFFIC ACCIDENTS AND THE EFFECT OF THE 1969 BREATHALYZER LAW IN CANADA

Classical epidemiologic indices have been applied to deaths and injuries from traffic accidents before and after the introduction of Canada's breathalyzer law. The disease frequency measures incidence, case-fatality, and mortality focus on the breathalyzer's health impact in relation to all the people at risk in a community over a specific period of time, permitting an on-going assessment of the effect of the breathalyzer law or other innovations in traffic safety. Population estimates for the years 1963 through 1971 were used to calculate the motor vehicle accident mortality and incidence rates for those years. Incidence, case-fatality, and mortality rates for each quarter were computed for the total day and also for four periods during the day: 6 a.m. to 12 noon; 12 noon to 6 p.m.; 6 p.m. to 12 midnight; and 12 midnight to 6 a.m. Two regression models were fitted to the incidence and case fatality data explaining the variation in terms of: a mean rate; seasonal effects; linear time trend; and breathalyzer effect. Estimates were calculated of the mortality rate that would have been expected if the breathalyzer had not been introduced. The difference between these predictions and the model's predictions including the breathalyzer effect represents an average reduction of 0.46 deaths per 100,000 population per quarter. The sum of the differences between the observed mortality rate and the model's predictions without the breathalyzer for the last five quarters represents a reduction of 8.2% or 487 deaths for Canada as a whole. The findings suggest that the introduction of the breathalyzer law corresponded to reductions in both the incidence of injury (with the greater reductions in incidence occurring during the heavy drinking period from 6 p.m. to 6 a.m.) and the case-fatality rate.

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HS-017 918

### LAW ENFORCEMENT REQUIREMENTS FOR THE DETECTION AND PREVENTION OF DRINKING AND DRIVING IN CANADA

The development of effective programs to ensure that law enforcement officers can detect and prevent drinking and driving in Canada is discussed. The Royal Canadian Mounted Police (RCMP) is the largest Federal law enforcement agency in Canada and is involved in a major way in the enforcement of both Federal and provincial statutes related to traffic and traffic safety. Despite the seemingly stringent provisions of the Canadian Breathalyzer Law of 1969, there has been no dramatic reduction in the incidence of drinking and driving, and there is still an alcohol-related involvement in over 50% of fatal motor vehicle accidents. The average blood alcohol concentration (BAC) determined through the breath analysis program has also not been lowered significantly. A variety of measures must be devised to accomplish a reduction in the

number of drinking drivers. Police officers must be properly educated to detect the drinking driver in the stages before the driver demonstrates severe intoxication. RCMP officers are exposed to as many aspects of the use of alcohol as is possible during a two-week training period. Police officers should also be trained to work with the public in community relations programs designed to prevent people from becoming prospective impaired drivers. The use of accredited breath alcohol screening devices at the roadside should be encouraged. Although some provinces permit the use of such screening devices to assist the police officer in enforcing an immediate 24 hour license suspension on the spot, the devices in use are generally of poor quality. Legislation should be enacted permitting a police officer to breath test any driver involved in any moving violation or accident. An effective public education program designed to develop an awareness of the effects of alcohol on driving ability is greatly needed in Canada. Educational programs to increase awareness of existing legislation and of the consequences of the alcohol involvement in motor vehicle accidents are also needed. Some breath test statistics for Alberta, Saskatchewan, Nova Scotia, and New Brunswick are presented by year, number of requests, number of tests, and mean BAC.

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1975 ; 2refs  
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HS-017 919

#### **ENFORCEMENT OF THE LAW IN GREAT BRITAIN REGARDING MOTORISTS IMPAIRED BY DRINK: SUCCESS AND PROBLEMS**

The British Road Safety Act of 1967, later incorporated into the Road Traffic Act, 1972, makes blood alcohol concentrations (BAC) in excess of 80 milligrams per 100 milliliters a statutory offense and contains provisions for the collection of blood or urine from drivers suspected of being impaired by alcohol. Successful prosecution under the Act almost invariably carries a minimum disqualification from driving of one year. The major success of the Act has been in connection with the ease with which it can be enforced rather than in the reduction of occasions when motorists drive impaired with alcohol. Although blood or urine samples are sent for analysis only after successful breath tests, between 15 and 20% of the blood samples have been found to contain less than the 80 milligrams per 100 milliliters limit provided in the law. About 5 or 6% are found to be below 50 milligrams per 100 milliliters. Although delays in the arrival of the doctor at the police station to take blood samples can account for a discrepancy of about 20 milligrams per 100 milliliters, figures below the 50 milligram level require some other explanation. Possible explanations include: failure on the part of the police officer to read the breath test device properly; a false positive breath test resulting from some trace of alcohol in the mouth; and an inaccuracy in the breath testing device. In addition to these problems attendant to testing for alcohol impairment, the absence of any legislation or any methods for assisting in the detection of motorists impaired by other drugs has led to a situation where this class of offenders is escaping attention.

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HS-017 920

#### **THE USE OF A SCREENING TEST FOR DRINKING DRIVERS IN CONJUNCTION WITH AN AUTOMATIC DATA PROCESSING UNIT**

Experience gained in New South Wales, Australia, has shown that in a program of any significant size designed to combat the incidence of drinking driving, the use of an automatic data processing unit to correlate the abundance of information available is essential. In 1973 in New South Wales, 27,601 drivers were subjected to breath screening tests for blood alcohol concentration (BAC), and 23,654 were subjected to subsequent breath analyses. With the information provided by the computer, the law enforcement agency concerned is able to marshal its resources to the best and most efficient possible advantage, deploying extra resources at high risk spots in various localities and at times when the problem is at its peak. The activities of the police throughout the entire state are clearly set out at monthly intervals by computer print-out for the information of senior police officers, making possible a degree of efficiency not otherwise possible. The information provided by the automatic data processing unit is used as a stock control method and to a large extent provides a safeguard against possible improper use of the equipment in the field. All of the 2,250 mobile police units in the state carry Alcotest screening equipment. Data collected on all persons subjected to a roadside screening test include: age, occupation, type of motor vehicle, age of motor vehicle, time of offence, location, reason for suspicion, and breath analysis results. The recent addition of name and date of birth to the information recorded by the data processing unit will make information relating to recidivism, particularly data concerning multiple offenders at the lower BAC levels, readily available.

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1975 ; 1ref

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HS-017 921

#### **COMPULSORY BLOOD ALCOHOL DETERMINATIONS IN ROAD CRASH CASUALTIES: EXPERIENCE FOLLOWING RECENT AUSTRALIAN LEGISLATION**

Australian legislation regarding alcohol and traffic safety followed initial studies of the blood alcohol concentrations (BAC) in dead drivers in the State of Victoria. These studies showed that about one-third of the drivers killed in traffic accidents had BACs in the area of 100 milligrams per 100 milliliters. In 1966, the State of Victoria adopted legislation requiring that all

drivers suspected of being under the influence of alcohol take breathalyzer tests and setting the maximum BAC at 50 milligrams per 100 milliliters. Laws passed later in other states set the maximum BAC at 80 milligrams per 100 milliliters. Since 1973, the states of South Australia and Victoria have passed laws providing for the compulsory testing of all accident victims for BAC. Initial experience indicates that there is a frequent association of elevated BAC with accident victims seen in hospital casualty departments. A significant proportion (6 to 8%) of these casualties have grossly elevated BACs of 150 milligrams per 100 milliliters or more. Other evidence indicates that such subjects have a long-standing drinking problem. Data from three Melbourne hospital casualty units and from hospitals in South Australia indicate that about 25% of all traffic accident victims have detectable blood alcohol.

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 Toronto, 1975, p717-22  
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HS-017 922

#### THE EFFECT OF REHABILITATION ON THE DRIVING BEHAVIOR OF PROBLEM DRINKERS

A statistical investigation of 782 persons was conducted to determine if successful treatment of alcoholism improves the driving performance of alcoholic drivers. The motor vehicle records of 391 experimental subjects and 391 control subjects were obtained from the appropriate Motor Vehicle Departments. The experimental group used was comprised of persons successfully rehabilitated through labor-management alcoholism programs. Nine companies in eight States were involved in the study. Significant improvements in total collisions, driving while under the influence of alcohol, reckless driving, other moving violations, suspensions, and revocations occurred after return to satisfactory job performance following treatment for alcoholism. While before treatment, the experimental group had significantly more convictions in these violations than the control group, after treatment there were no significant differences between the groups. It is suggested that the motor vehicle records are inadequate and not well standardized and that youthful drinking drivers may not respond in the same manner as the older group of persons used in this study.

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HS-017 923

#### A COMPARISON OF CHANGES IN KNOWLEDGE AND ATTITUDE BETWEEN PROBLEM DRINKERS

#### AND NON-PROBLEM DRINKERS FOLLOWING A REEDUCATION PROGRAM

The New York State "DWI Counterattack" program is an experimental program being conducted by the New York State Automobile Association and the New York State Department of Motor Vehicles designed to reduce the problem of driving while intoxicated (DWI). Versions of the program are operative in three counties: Erie, Onondaga, and Westchester. This program substitutes reeducation and rehabilitation for traditional punitive measures for DWI violations. Participation is voluntary, and convicted motorists who take part in the program retain their driving privileges if they attend all sessions of the course held once each week for five consecutive week-day evenings. The aims of the course are to provide information on the consequences of drinking and driving and to consider why people drink and drive, as well as to consider what countermeasures they can take. The 566 DWIs who attended all sessions of the course to which they were assigned were divided into the following three groups: no drinking problem; potential drinking problem; and definite drinking problem. Tests administered before and after the course included: the Drinking and Driving Knowledge Inventory (KI); the Drinking and Driving Opinion Survey (OS); Behavioral Description Scales (BDS); and Alcoholism Indicator (AI). Although no problem drinkers seemed to show greater OS improvement than potential problem and definite problem drinkers combined, no relation was found between drinking problem classification, as defined by AI, and knowledge and attitude change. The findings clearly suggest that those DWIs suffering more serious and pervasive problems with alcohol gain significantly in knowledge about DWI and to the same extent as other DWIs. The difference in attitude changes between non-problem drinkers and DWIs with potential or definite drinking problems suggests that it might be profitable to encourage the latter group to become involved in follow-up experiences designed to produce additional attitudinal and behavioral changes.

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 Toronto, 1975, p737-53  
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HS-017 924

#### JUDICIAL DISCRETION IN DRINKING-DRIVING CASES: AN EMPIRICAL STUDY OF INFLUENCES AND CONSEQUENCES

Judges of the Denver, Colorado, County Court agreed to assign penalties of a fine, conventional probation, or rehabilitative probation according to a fixed schedule to 495 drivers convicted of a first offence of driving while intoxicated. However, when the judges departed from the schedule in a significant number of cases, the scope of the study was expanded to study the exercise of judicial discretion. The study was designed to find out under what conditions the judges used their discretion to deviate from the scheduled sanctions and what the differences in subsequent driving records of defendants receiving scheduled and those receiving unscheduled sanctions were. Only when comparing the jail to the non-jail groups did a rational basis for deviations from scheduled sanction assignment appear, with defendants having poorer previ-

ous records being sent to jail. When deviations from scheduled conventional or rehabilitative probation were examined, lawyer representation appeared to be the principal influence, with represented defendants most often receiving a preferred fine. Comparison of the records of those receiving scheduled and unscheduled sanctions for one year subsequent to the application of the sanction did not show any benefit of the exercise of judicial discretion in deciding to deviate from the agreed sanction. There were no significant differences between the subsequent records of defendants given jail and those given non-jail treatment or between defendants receiving scheduled rehabilitative probation and those receiving unscheduled sanctions. Tabulations of defendant sentencing by age, sex, minority status, previous crashes, violations, and points, and lawyer representation are provided.

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HS-017 925

#### **THE EFFECT OF LOWERING THE LEGAL DRINKING AGE IN ONTARIO ON ALCOHOL-RELATED MOTOR VEHICLE ACCIDENTS**

Data on the number of drinking drivers, by age, who have been involved in motor vehicle accidents in Ontario, Canada, in the years 1967 through 1971 were examined to assess the effect of lowering the drinking age from 21 to 18 (in 1971) on alcohol related traffic accidents. While there has been a long term trend for drinking drivers involved in accidents to be younger than previous years, this trend became more pronounced in 1971. In addition, the trend before lowering the drinking age was attributable to both the 16 to 19 and the 20 to 24 year age groups, while the increase in 1971 is concentrated in the younger group. It seems likely that most of the reported increase in 1971 in the proportion of 16 to 19 year old drinking drivers in accidents is the result of lowering of the drinking age rather than a continuation of the earlier trend.

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HS-017 926

#### **THE IMPACT OF THE CHANGE IN THE DRINKING AGE ON THE COLLISION BEHAVIOUR [BEHAVIOR] OF YOUNG DRIVERS**

A study designed to assess the impact of the reduction in the legal drinking age from 21 to 18, (effective in Ontario, Canada in July 1971) on the collision behavior of young drivers in the community of London, Ontario, is discussed. Data from collisions occurring between January 1968 and June 1973 which in-

involved drivers aged 16, 17, 18, 19, 20, or 24 was examined for information on the age and sex of the driver, the year of the collision, the time of day, and the condition of the driver. The use of a quasi-experimental design permitted control for the major hazards to internal and external validity. The data show that alcohol-related collisions increased 339% among 18 year olds and 346% among 19 year olds during the period after the change in the law, while their total number of collisions increased 42% and 37% respectively. Sixteen and seventeen year olds showed an increase of 162% in alcohol related accidents and a 20% increase in total collisions. Twenty year olds showed a 156% increase in alcohol related accidents and a 16% increase in total collisions. At the same time, the 24 year olds showed a 20% increase in alcohol related accidents after the change in the law and a 10% increase in total collisions. In addition, after the change in the law the percentage increase in total collisions was significantly larger from 9 p.m. to 3 a.m. than from 9 a.m. to 3 p.m. for all groups aged 16 through 20, while the increase for 24 year olds was almost entirely in the 9 a.m. to 3 p.m. period. The data indicate that the change in the drinking age had an independent effect of increasing the incidence of alcohol-involved collisions and total collisions among young drivers. While among 18 to 20 year olds it is possible that half of the increased rate of total collisions may have been due to non-drinking factors, it is difficult to account for the other half of the total increase in collisions in any other way. However, among 16 and 17 year olds it appears that the increase in collisions is due almost exclusively to the change in the drinking law.

by Paul C. Whitehead; John Craig; Nanci Langford; Carol MacArthur; Bruce Stanton  
University of Western Ontario, Dept. of Sociology, London, Canada  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p771-4  
1975 ; 2refs  
Summary of the paper presented to the Sixth International Conference on Alcohol, Drugs and Traffic Safety. Part of a larger study supported by the Canada Council of Young Drivers. Prepared in cooperation with Roberta G. Ferrence. Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 927

#### **THE COMPULSORY BREATHALYZER .05% LEGISLATION IN VICTORIA**

A law stipulating that a driver found to have a blood alcohol concentration (BAC) in excess of 0.05% within 2 hours of apprehension is prima facie guilty became effective in February 1966, in the State of Victoria, Australia. Offences involving alcohol and driving include: driving a motor vehicle with a BAC greater than 0.05%; drunken driving, or driving under the influence to such an extent as to be incapable of having proper control of the vehicle; and drunk in charge, where the car is not in motion, but there are grounds for suspicion that it is about to be driven. Legislation requiring that all traffic accidents victims admitted to hospitals be blood tested for alcohol has recently been enacted. The overall mean value of the drinking driver in the hospital, mortuary, or apprehended at the scene of an accident is about 0.15%. Comparison of a 10% sample of breathalyzed Victorian drivers with a control sample of male drivers showed that the breathalyzed drivers had more traffic convictions of any kind than the controls, three times as many traffic convictions for offences other than



speeding, 10 times as many serious traffic offences, 10 times as many drinking driving convictions, three times as many license withdrawals, and 10 times as many convictions for unlicensed driving. Almost 40% of the breathalyzed drivers had criminal records for offences other than on the roads. Follow-up studies of 300 drivers convicted of drinking driving offences conducted over a 2.5 year period showed that about 40% of the drivers were reconvicted of either criminal or driving offences during the follow-up period, of which half of the offences were for drinking driving.

by J. H. W. Birrell  
Victoria Police Dept., Melbourne, Australia  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p775-85  
1975 ; 17refs  
Paper from the Proceedings of the International Conference  
(6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 928

### DRUNK DRIVING: OUTLINE OF A PUBLIC INFORMATION AND EDUCATION PROGRAM

An overview of the activities and interests of the National Highway Traffic Safety Administration (NHTSA) in public education related to alcohol safety issues, some of the public opinion survey research being conducted in this area, and priorities and plans for future public information and education programs is presented. The basic assumption of the entire Alcohol Countermeasures Program is that excessive, abusive use of alcohol by a relatively small segment of drivers causes most alcohol-related fatalities, rather than normal, moderate use. An intensive publicity campaign has included the use of print, radio, and television space for alcohol safety campaign materials. Public opinion surveys conducted in 1970 and 1973 indicate that public concern and awareness of the problem of drinking driving is increasing. Research designed to define appropriate target audiences for further education efforts involved conducting 1,660 personal interviews among a national probability sample of adults between the ages of 18 and 55. Survey responses showed that respondents ranked drunk driving fifth when asked to rate the importance of various national death-causing problems. About 75% of the respondents felt that it was an extremely or very important problem. Of the individuals who said they found themselves in an alcohol-related situation at least once a month (54% of the total sample), about 80% were involved in such situations outside their own homes. Of this group of people who became involved in alcohol-related situations at least once a month, only 25% felt that a drunken teenager or problem drinker could get home safely without incident, while 50% felt that an average social drinker could get home all right. Future priorities of the NHTSA Alcohol Countermeasures Program are: to document the effects of the public education programs at a national level; to give support and to upgrade the capability of states and communities to conduct professional communication programs; and to coordinate activities with governmental, private, and voluntary organizations nationally and internationally.

by Dwight Fee  
Department of Transportation, Washington, D.C.  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p789-98  
1975  
Paper from the Proceedings of the International Conference  
(6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 929

### PUBLIC INFORMATION PROGRAMS RELATED TO ALCOHOL, DRUGS, AND TRAFFIC SAFETY

Attempts to reduce highway accidents involving alcohol generally include public information campaigns. Until recently the target audience of these campaigns has been the consumer who, it is assumed, will be in a position to choose whether to drive while in an impaired condition. In the last few years, a number of campaigns have focussed instead on informal influence agents such as friends, relatives, and party hosts who are in a position to control a person's access to alcohol or drugs, or to a car, or to both. These persons can exert influence before a violation or an accident occurs. Programs directed at the general public are usually designed to increase awareness of the problem or to solicit support for control measures. Other programs may be directed exclusively at young people, minority groups, employers, or other select audiences. Themes used in public information campaigns include: conveyance of information; utilization of some form of threat, such as loss of life or arrest; invocation of normative values, such as the value of knowing personal limits; or appeal to concern for the common good. Although the ultimate objective of campaigns in this field is a reduction of injuries or fatalities on the highway, most campaigns focus on such intermediate objectives as appropriate changes in beliefs or attitudes and institutional or organizational changes. Most campaigns on drinking and driving have not been evaluated in any systematic way. As a result, it is not possible to provide definitive conclusions regarding the relative effectiveness of the various appeals used. Examples of campaign materials are illustrated.

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Children's Television Workshop, One Lincoln Plaza, New  
York, N.Y. 10023  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p799-811  
1975  
Paper from the Proceedings of the International Conference  
(6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 930

### THE INVESTIGATION OF BLOOD ALCOHOL LEVELS IN 967 ROAD ACCIDENT FATALITIES

The relationship between alcohol and road fatalities in the State of Victoria, Australia, during the period 1970 to 1973 was investigated using the blood alcohol concentrations (BAC) estimated on 967 post-mortems conducted on road accident victims. During the period from June 1970 to May 1971, post-mortems performed on 400 road accident victims showed that of the 171 drivers killed, 103, or 60%, had ingested alcohol. About 50% of the total 171 drivers killed had BACs exceeding 100 milligrams per 100 milliliters, double the legal limit in Victoria. Pedestrian deaths revealed that about 54% had very high BACs. A fairly low-key public education campaign about drinking and driving directed at the driving public followed this stage of the investigation, after which 567 post-mortems were conducted on fatal accident victims during the period January 1972 to June 1973. Of the 251 killed drivers analyzed for alcohol, 46.6% had BACs in excess of the legal limit. While there has been no significant change in the BACs of killed drivers, there has been a significant reduction in the death toll and accidents involving casualties in the State of Victoria over the past 3 to 4 years. This pattern has not been experienced throughout Australia.

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3000, Victoria, Australia  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p825-30  
1975 ; 2refs  
Paper from the Proceedings of the International Conference  
(6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 931

# **THE EDMONTON STUDY. A PILOT PROJECT TO DEMONSTRATE THE EFFECTIVENESS OF A PUBLIC INFORMATION CAMPAIGN ON THE SUBJECT OF DRINKING AND DRIVING**

A study designed to examine the effectiveness of a public information campaign on the subject of drinking and driving in Edmonton, Alberta, Canada, is described. The campaign, planned and conducted by the Canada Safety Council, was aimed at changing knowledge, attitudes, and behavior by: alerting the public to the seriousness of the traffic accident problem related to the irresponsible use of alcohol; outlining the action of alcohol and the dangers when related to the driving task; reviewing the penalties for impaired driving; and suggesting changes in drinking-driving behavior. Materials were directed at the social drinker. A before and after survey of drivers in Edmonton and in a control city (Calgary) was conducted to evaluate the effect of the campaign. A randomly selected sample of drivers were stopped during roadside surveys which included blood alcohol concentrations (BAC) analysis and interviews to test the level of knowledge about various points which had been emphasized in the campaign and attitudes towards present drinking-driving laws. Over 2,000 drivers were interviewed in each city during each phase. Although the control city had conducted a normal holiday season traffic safety campaign, only the Edmonton campaign was successful in producing a significant decrease in the proportion of impaired drivers on the road. Both campaigns resulted in increased knowledge about particular points and in changed attitudes towards existent laws. Few adults or teenagers in the Edmonton area did not receive the message about drinking and driving, and most received it many times in many different ways. The Edmonton campaign was well received by the public and was successful in achieving the desired behavioral change.

by Philip J. Farmer  
Canada Safety Council, Ottawa, Ont., Canada  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p831-43  
1975 ; 4refs  
Paper from the Proceedings of the International Conference  
(6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 932

# **SEVEN YEARS EXPERIENCE OF BLOOD-ALCOHOL LIMITS IN BRITAIN**

Experiences in Great Britain with regard to drinking and driving following the passage of the Road Safety Act 1967, which established a maximum blood alcohol concentration (BAC) and provided for the use of breath analysis as a screening test, are discussed. A short history of the control of drinking and driv-

ing in Britain is presented. The 1967 law required courts to disqualify offenders from driving for a year. While the new law was supported by a heavy publicity campaign and the severity and certainty of the penalty was widely known, individual drivers did not know the likelihood of being required to submit to a breath test or the amount of drinking which would result in an illegal BAC. Although the law was highly deterrent in the initial stage, this effect has largely worn off as the perceived risk of being required to take a breath test has decreased. This apparent decline in the deterrent effect of the legislation has been accompanied by a continual increase in the number of breath tests administered and therefore the actual risk of apprehension. The lack of concerted government publicity against drinking and driving during the last five years may have contributed to this decreased perception of risk of apprehension by the police. Data for the years 1968 through 1972 show that about 96% of the 170,000 positive breath tests confirmed by analysis lead to prosecutions, over 90% of which lead to conviction. Criteria for use in drafting legislations regarding drinking and driving are presented.

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England  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p845-53  
1975 ; 7refs  
Paper from the Proceedings of the International Conference  
(6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 933

# **SOCIO-MEDICO-LEGAL ASPECTS OF ALCOHOL AND ALCOHOLISM**

A discussion of the social, medical, and legal aspects of alcohol and alcoholism in the United States is presented. It has been estimated that more than 80,000,000 persons in the United States use alcoholic beverages, of which 6% are considered excessive users and possible problem drinkers. The American culture recognizes religious approval and disapproval and the aspects that promote utilitarian acceptance in determining attitudes toward the consumption of alcohol. Paternalistic attitudes of governmental agencies and persons responsible for the treatment of the alcoholic resulted in the prevalence of punitive and moralistic approaches to treatment in the past. This attitude toward alcoholics and alcoholism has now changed somewhat into a disease orientation. Treatment milieus involving strong support by other members, group therapy, and a quasi-psychophilosophic approach have achieved a remarkable success with alcoholics. Treatment of the individual alcoholic must take into account the individual's socio-economic background, cultural heritage, ecological-nutritional-disease inventory, and psychologically evaluated personality traits. Research conducted on alcoholism indicates the need for a wide variety of measures, including new techniques for the rehabilitation of alcoholics, liaison between agencies researching or treating alcohol problems, a data bank source of information relating to alcoholism, and the development of tools for evaluating the needs of individual alcoholics.

by Robert J. Joling  
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Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety,  
Toronto, 1975, p855-9  
1975 ; 11refs  
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(6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 934

**CAN ALCOHOL EDUCATION CHANGE THE ROLE OF YOUTH ON OUR HIGHWAYS?**

Although alcohol education cannot change the role of youth on the highways, since what happens to young people while driving is more related to 'growing up' than to excessive drinking, such educational programs can be useful in creating a sensible attitude toward alcohol. The vast amount of alcohol education material currently available is chiefly concerned with formal teaching. The following suggestions relating to actions which can be taken by the government, the community, parents, and concerned individuals to improve the alcohol education of young people are discussed: abolish the conventional grading system in alcohol education courses; teach students how to drink sensibly; improve driver training; have students participate in the development of alcohol education curricula; lower, or eliminate entirely, the legal drinking age; remove the driver's license of an alcoholic or problem drinker who has been judged guilty of driving while intoxicated; conduct more and better alcohol education research; attempt some alcohol education at the time the student receives a license to drive; begin alcohol education at the kindergarten level and make it part of a total health education program; involve parents, teachers, and other adults in the community in corollary alcohol education courses; and research the role of advertising and media programming in influencing youthful drinking patterns.

by Lee N. Hames

American Medical Assoc., Chicago, Ill. 60610

Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety, Toronto, 1975, p861-8

1975 ; 34refs

Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974.

Availability: In HS-017 850

HS-017 935

**EXPERIMENTAL EVALUATION OF A COMMUNITY-BASED CAMPAIGN AGAINST DRINKING AND DRIVING**

A pre-test/post-test control group design was used to assess the effectiveness of the different components of a drinking-driving campaign in nine cities in Ontario, Canada. Telephone surveys were conducted in these nine cities and in a control group of nine other cities before and after a media campaign stressing citizen involvement and community action in dealing with the drinking-driving problem. People chosen for the samples were randomly selected from the file of licensed drivers and were sent an advance letter to advise that the call for an interview would be forthcoming. Independent samples were used for the before and after surveys and consisted of 1,120 persons in the campaign cities and 1,053 persons in the control cities for each survey. Results of the surveys indicate that the campaign was effective in increasing the number of people who reported not driving home when they were drunk; it informed people of the maximum legal blood alcohol level; it informed people that jail was a possible penalty for drinking and driving; and it increased the number of conversations about drinking and driving. The research design used in this study provided means for avoiding the problem of historical and seasonal effects and eliminated the common problems of pre-test sensitization, instrumentation effects, and lack of homogeneity among survey samples.

by J. Pierce; D. Hieatt; M. Goodstadt; L. Lonero; A. Cunliffe; H. Pang

Ministry of Transportation and Communications, Downsview, Ont., Canada

Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety, Toronto, 1975, p869-79

1975

Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974.

Availability: In HS-017 850

HS-017 936

**THE ROLE OF ATTITUDES IN SECONDARY SCHOOL ALCOHOL-TRAFFIC SAFETY EDUCATION**

The role of attitudes toward alcohol and traffic safety education, toward drinking, and toward driving on the part of students, teachers, and school administrators in secondary school alcohol and traffic safety education programs is examined. Teachers should remain entirely neutral in the classroom in terms of expressing views about whether their students now or in the future should drink, how much they should drink, and under what conditions they should drive because students must come to their own conclusions about drinking in order to learn the process of independent thinking and because the expression of attitudes on these subjects will destroy the teacher's chances of producing any rational examination on the part of the students of how they should drink and drive. Reasons why expressly seeking to produce specific responsible drinking and driving behaviors will not work for many students include: students will tend to concentrate on becoming adept at supplying the desired responses in class rather than on the development of responsible attitudes toward drinking and driving; young people reject being told what is right and wrong and are finely attuned to the hypocrisy of how adult behavior belies adult precepts; students are insulted by the teacher's implicit assumption that, given the facts and the opportunity to discuss their feelings, they are too dumb to come to their own reasonable conclusions about how to drink and drive; and students will be discouraged from examining their own attitudes toward drinking and driving. Small group discussions and role playing situations can be used to permit an open expression of student concerns about drinking and driving, including the influence of peer group pressure, the search for kicks or danger, the need to emulate adults, and the "it-won't-happen-to-me" type of rationalization. School administrators must explicitly and publicly support teachers attempting to create an atmosphere of teacher neutrality and student openness if such programs are to be successful. An example of classroom activities stressing small group discussions and role plays is provided.

by Peter Finn

Abt Assoc., Inc., Cambridge, Mass.

Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety, Toronto, 1975, p881-8

1975 ; 10refs

Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974.

Availability: In HS-017 850

HS-017 937

### ONE MODEL FOR THE EVALUATION OF ASAP REHABILITATION EFFORTS

A model has been developed for the evaluation of the Alcohol Safety Action Projects (ASAPs) rehabilitation efforts, which are designed to modify the behavior of persons convicted of driving while intoxicated (DWI) in a manner that will reduce the probability of subsequent DWI behavior. The structural characteristics of ASAP education and group therapy modalities, as they evolved in 27 different communities, were identified and described. The alcohol safety schools were then grouped into categories or types which were more homogeneous in terms of such organizational characteristics in order to compare the effectiveness of different school types in the reduction of arrest recidivism. Tasks conducted in this effort included: selection of a suitable criterion measure for evaluating treatment program effectiveness; selection and modification of a criterion data collection procedure; selection of a suitable method for calculating recidivism rates; selection of a formula for transforming recidivism data into a form appropriate for data analysis; specification of the differences between various drinker types; development of a device for specifying the characteristics of various modality types; selection of a procedure for discriminating between various modality types; and conducting appropriate statistical analyses of recidivism rates between drinker types, school types, and interactions of drinker and school types. Although the results of this study show that a broad range of activities and orientations exist under the single classification of alcohol safety school, the study was unable to show that school types were differentially effective. The variety of alcohol safety schools suggests the possibility of matching school type modalities with drinker types.

by James L. Nichols; Raymond E. Reis  
National Hwy. Traffic Safety Administration, Office of Driver and Pedestrian Programs, Washington, D.C.  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety, Toronto, 1975, p893-926  
1975 ; 27refs  
Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 938

### MOTOR CLAIMS OF ABSTAINING DRIVERS

Motor accident statistics gathered by Swedish insurance companies from actual claims records were used to assess the differences in claims frequencies and costs between total abstainers and non-abstainers from alcohol. Since 1933 Ansvar Mutual Insurance Company in Sweden has issued insurance policies only to total abstainers, who declare that they abstain from beverages with an alcohol content in excess of 2.25% by volume. The claims ratio for Ansvar's policyholders was significantly lower than that of policyholders with other insurance companies during the period 1933 through 1955. In 1957 all other insurance companies in Sweden introduced special discounts to total abstainers. The data provide conclusive indication that the claims frequencies for total abstainers is lower year by year than the claims frequencies for non-abstainers. The balanced average for the entire period 1957 through 1972 shows that the claims ratio is 10% lower for the total abstainers than it is for the general group. Total abstainers insured in an abstinence groups with insurance compa-

nies other than Ansvar also have lower claims frequencies on average than non-abstainers. For the period 1957 through 1972 the average claims frequency for total abstainers insured in special groups with other companies was on average 6% below the general group. Claims comparisons indicate that a total abstainer exposes himself to less risky situations than non-abstaining policy-holders. The Ansvar Group of insurance companies, insuring total abstainers only, shows a consistent pattern in every country where the company is working and where the statistical data are available for comparisons, of a lower claims frequency than other insurance companies.

by Ake Lindgren

Ansvar Mutual Insurance Co., Stockholm, Sweden  
Publ: HS-017 850, Alcohol, Drugs, and Traffic Safety, Toronto, 1975, p927-36  
1975 ; 1ref

Paper from the Proceedings of the International Conference (6th) held in Toronto, 8-13 Sep 1974.  
Availability: In HS-017 850

HS-017 939

### BIOENGINEERING STUDY OF BASIC PHYSICAL MEASUREMENTS RELATED TO SUSCEPTIBILITY TO CERVICAL HYPEREXTENSION-HYPERFLEXION INJURY. FINAL REPORT

Basic physical characteristics of the neck which may influence a person's susceptibility to 'whiplash' injury during rear-end collisions were investigated using 180 human volunteer subjects chosen on the basis of sex, age, and stature to be representative of the adult population of the United States. The following measurements were obtained from each subject: 48 anthropometric measures, mostly of the head and neck; 16 anthropometric measures of the cervical spine; four replications of sagittal plane flexion and extension range of motion; range of motion of the cervical spine; neck muscle stretch reflex and reaction times; and voluntary neck muscle strength. A combination of x-rays and photographs was successfully used to determine that the cervical range of motion is consistent over several replications. The range of motion of the head and neck was found to be significantly reduced in older subjects. Female neck muscle strength is considerably less than that of males. While males and females exhibit different aging characteristics, all elderly subject groups revealed considerably reduced strength capability. The average male was nearly twice as strong as the average female. The average stretch reflex time of the neck flexor muscles was faster for females than for males of the same age. A technique has been developed which can be used to predict muscle force exerted during a reflex test. The experimental data for range of motion and muscle strength were used in the Highway Safety Research Institute Two-Dimensional Crash Victim Simulator to investigate the effect of the measured parameters on dynamic response in a simulated 30 mph rear-end collision. The small elderly female group was found to be the most susceptible to injury. Regardless of the population group, active neck muscle tension modified head and neck dynamic response. Both the experimental and the modelling results suggest that certain segments of the population--particularly females, regardless of age, and elderly males--are more likely than others to sustain neck injuries in a given rear-end accident situation.

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and Baxter Rd., Ann Arbor, Mich. 48105  
Contract ORA-72-613-B1  
Rept. No. UM-HSRI-BI-75-6 ; 1975 ; 323p 99refs  
Sponsored by Insurance Inst. for Hwy. Safety, Watergate Six  
Hundred, New Hampshire Ave., N.W., Washington, D.C.  
20037. Report for 15 Jan 1972-15 Sep 1973.  
Availability: Insurance Inst. for Hwy. Safety, Watergate Six  
Hundred, New Hampshire Ave., N.W., Washington, D. C.  
20037

HS-017 940

### **INVESTIGATIONS INTO LIGHT TRAFFIC I [BICYCLES, MOTORCYCLES]**

The use of safety equipment by riders of bicycles and motorcycles in Finland was investigated. Reports are presented on the following specific items: the use and equipment of school children's bicycles; bicycle reflectors; the use of warning flags on bicycles; and the use of safety helmets and goggles by motorcycle and moped riders. An examination of over 600 bicycles showed that about 75% of the bicycles had all the required equipment in good condition and properly placed. However, non-required safety equipment such as rear lights and rear mirrors were generally lacking or not in order. Poor condition of the bicycle can be considered a significant factor in bicycle accidents. Although children manage well in traffic with bicycles, more bicycle routes would provide an efficient means of increasing bicycle safety. A survey of 8,118 bicycles revealed that only 11% had a good reflector with a luminance coefficient of over 100 mcd/lux. More than half of the bicycles were fitted with a very weak reflector. Experimental data indicated that vehicle drivers yield more to bicycles fitted with a warning pennant than to those without such a device. Although there are no helmet laws in Finland, a survey of 14,588 motorcycle operators and passengers showed that 76.6% of the operators and 54.9% of the passengers were wearing helmets. The helmets are worn more in rural areas than in towns and more on weekends than during the business week. About 58% of the observed motorcycle riders were using goggles. The use of safety helmets and goggles by moped riders is very uncommon, averaging about 2 or 3%. Tables are given on bicycle equipment condition, children's bicycle trip length by sex, and children's accident severity by sex. Interview forms used in parent and child surveys of bicycle usage, equipment, and accident experience, and of warning flag use are shown.

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Rept. No. Liikenneturva-16 ; 1975 ; 43p refs  
Availability: Corporate author

HS-017 941

### **TRAFFIC EDUCATION PROGRAMME FOR PRESCHOOL AGED CHILDREN AND CHILDREN STARTING SCHOOL**

A traffic education program for preschool-aged children and children starting school, to be used jointly by parents and teachers, is presented, and the results of an experimental application of the program at three kindergartens are reported. The experimental program was designed to determine the

manner in which the external conditions of training co-operation should be arranged to make co-operation efficient and to determine the guidance needed by parents and teachers in order to carry out their educational tasks. A film and a series of slides were prepared as training aids. It was found that the efficiency of training could be increased, particularly if the behavioral models were first trained by the film or slides and if this instruction was linked with personal training of the child under actual traffic conditions. The 10 situations to be covered were: entrance to street from yard; walking on highway; walking on sidewalk; pedestrian crossing; stopping; looking aside and behind; looking out for automobiles; dangerous spots; tempting actions; and traffic signal lights. The objective of traffic education for this age group is to ensure the child's safe movement from within the limits posed by developmental tasks concerned, such as moving from home to school or playing outside alone. Information given to the parents can help the parents to assess the time at which they can safely allow their child to move alone in traffic. A well-functioning framework for practical co-operation between teachers and parents is essential to the success of the traffic education program outlined. The materials used in the training program (including the contents of each of 69 slides) are described and the process used in the experimental applications are discussed.

by Tapio Nummenmaa; Kaarin Ruuhilehto; Matti Syvanen  
Liikenneturva, Central Organization for Traffic Safety, Iso  
Roobertinkatu 20, 00120 Helsinki 12, Finland  
Rept. No. Liikenneturva-17 ; 1975 ; 64p 1ref  
Availability: Corporate author

HS-017 942

### **THE PEDESTRIAN REVOLUTION. STREETS WITHOUT CARS**

The development of improvements in the provision of services and facilities for pedestrians in urban areas is examined. Pedestrian islands and pedestrian districts both provide ways to recapture urban open spaces for human use, and lace restrictions on the movement of conventional vehicles within their boundaries. The creation of pedestrian islands involves the conversion of existing street space to pedestrian uses. This may involve sidewalk and roadbed changes, additional landscaping, and the purchase of benches and pedestrian-scale street furniture. The creation of park streets necessitates the elimination of vehicular traffic from existing streets and converting the streets to parks and playgrounds through the addition of plants and trees, play equipment, and places to sit. Pedestrian districts create entirely new walking areas and are not limited to present street patterns. Possible types of pedestrian districts include: thru-block walkways; underground streets; work-residence districts, in which opportunities for both work and residence are within walking distance or mini-vehicle range; development of areas around civic centers as vehicle-free areas; and the development of urban strollways connecting pedestrian islands. Urban bikeways should be developed to encourage the use of this safer and less polluting form of transportation in urban areas. To be safe, a bikeway must be free of conventional vehicles, and it must connect major residential areas with the central business district in order to be convenient. Bicycle rental, storage, and maintenance facilities could be used to encourage the regular use of bicycles for transportation. Other mini-vehicles which could be used in pedestrian areas might include electric passenger tractor trains, tricycles for adult use as transport and package car-

riers, pedal-powered vehicles, and battery-powered scooters. Suburban cluster developments can be easily designed to have large amounts of open space without increasing land requirements for the development. Local governments should create Departments of Pedestrians, with a Pedestrian Advocate as the head, to be responsible for pedestrian engineering. A Pedestrian Bill of Rights is included.

by Simon Breines; William J. Dean  
1974 ; 151p refs  
Availability: Vintage Books, New York

HS-017 943

### TRAFFIC VIOLATIONS IN RELATION TO DRIVER CHARACTERISTICS AND ACCIDENT FREQUENCY. FINAL REPORT

The relationship between traffic violations and driver characteristics and accident frequency was investigated. Data previously collected on over 14,000 California drivers were examined to determine the interrelationships among violation types, accidents, total convictions, and the variables of sex, age, marital status, occupation, and exposure. Analysis of this data indicated that knowledge of prior violation experience can improve the prediction of future accidents, with different categories of violations useful for males and females. Violations relating to failure to obey laws and regulations and major violations such as hit and run accidents were found to be most effective as predictors for males, while violations related to poor driving practice are better predictors for females. Although violation experience was found to vary with age, sex, marital status, occupation, and exposure, some of this variation may be the result of interactions among these factors. A cost-effectiveness analysis must be performed before the advantages of using prior violation experience to help predict future accidents can be accurately assessed. In addition, the following areas should receive further research and investigatory attention: analysis of the most common violation patterns or combinations that appear on multiple-violation convictions; the effect of selective enforcement procedures on violation patterns appearing on multiple-violation convictions; the relationship between age and the incidence of different violation types; and the factors in marital status that make this variable valuable in the prediction of accidents.

by Albert Burg  
University of California, Inst. of Transportation and Traffic Engineering, Los Angeles, Calif. 90024  
Rept. No. UCLA-ENG-7455 ; 1974 ; 59p 13refs  
Prepared in cooperation with the Federal Hwy. Administration, and supported in part by the California Business and Transportation Agency.  
Availability: California Dept. of Transportation, Sacramento, Calif. 95807

HS-017 944

### MOTOR CARRIER ACCIDENT INVESTIGATION. MT. ZION BAPTIST CHURCH. ACCIDENT--MAY 30, 1975--MILWAUKEE, WISCONSIN

An investigation of an accident involving a 1966 passenger bus leased by the Mt. Zion Baptist Church of Zion, Illinois, which occurred in Milwaukee, Wisconsin on May 30, 1975, is reported. The bus (traveling at 45 mph) veered out of control, struck a median concrete divider, rebounded across three traf-

fic lanes, and overturned down an embankment on the right side of the roadway killing two persons, injuring 11 persons, and causing 30,000 dollars worth of property damage. The accident investigation revealed that the accident was caused by poor judgment on the part of the bus driver in that he failed to correct a dangerous mechanical condition (the accelerator pedal sticking in the depressed position), passed several opportunities to have it corrected, and continued on the trip with a known defect. The driver attempted to correct the problem by fashioning a loop from a coat hanger and placing it around the accelerator pedal to return it to idling position by hand after being depressed. The use of this makeshift device presented an even more dangerous situation, since the driver had to use one hand to control the loop, leaving only one hand free for steering. His attention was diverted from steering and other driving duties on the dark, rain-wet roadway. The driver lost control of the bus about 4 miles from the point where the accelerator problem was first noticed. The driver's lack of experience and/or mechanical expertise may have contributed to his failure to recognize the dangerous situation confronting him by continuing on his trip and operating an unsafe vehicle during inclement conditions.

Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D.C. 20590  
Rept. No. BMCS-75-3 ; 1975 ; 9p  
Availability: Corporate author

HS-017 945

### CONTINUOUSLY-VARIABLE TRANSMISSIONS

The automatic transmission has finite-step shifts that prevent optimization of the automobile engine in terms of fuel economy and power in operation. A wide-ratio, continuously-variable transmission may permit designs to treat the automobile's propulsion package as a total system in which the engine can produce its power under optimized conditions. Engine size could be significantly reduced, bringing about benefits in weight reduction and fuel economy. The cone roller toroidal drive (CRTD) has been in development for many years and it has reached a state of technical maturity. For automotive use the CRTD ratio design is now twelve to one. The service clutch in the twelve to one CRTD transmission is only required at startup, to bring the vehicle to about 3.5 mph. Actual ratio change of the power rollers is made through individual hydraulic cylinders operating in parallel; these are arranged to support the tangential traction forces on the rollers. Use of the revolution per minute versus torque control provides unique advantages. The point where the programmed revolution per minute versus torque curve crosses the engine horsepower curve at peak power becomes a stable point. Also, the selected control curve predetermines the exact operational condition for all-demand power or throttle conditions. Cars equipped with a CRTD transmission consistently demonstrate faster initial acceleration. The CRTD car will suffer a loss of top speed acceleration, but with the 55-mph national speed limit this is not a serious drawback. Schematics, and performance and efficiency curves for the CRTD are provided.

Publ: Automotive Engineering v83 n12 p36-9 (Dec 1975)  
1975

Based on SAE-751180, "A Continuously Variable Transmission for Automotive Fuel Economy," by J. H. Kraus, C. E. Kraus, and M. E. Gres, Excelsomatic, Inc. For presentation at the SAE South Texas Section Meeting, San Antonio, 28 Jan 1976.  
Availability: See publication

HS-017 946

**ALTERNATIVE AUTOMOTIVE POWERPLANTS**

Over a period of about 18 months, the Jet Propulsion Laboratory (JPL) studied the technologies available for improving the automobile and its powerplant. The automobile will maintain its dominant role in personal transportation. Public transit will, at the most, substitute for 10 to 15% of the automobile driving in the next 10 to 20 years. A major change in automobiles cannot happen overnight, regardless of the amount of money made available. Liquid fuels, natural and/or synthetic, will be used in cars at least to the end of this century. The materials can be obtained for the construction of the heat-engine-powered automobiles. The financial resources required for conversion to vehicles with alternate engines would be readily available in the U.S. economy. Pollutant emissions must be more stringently controlled. Automobiles with catalytically controlled Otto-cycle engines do not need to give up fuel economy to comply with the strictest emission standards. The JPL study recommends: the implementation of design changes in the car itself to reduce fuel consumption; the development of two promising engines, the Brayton and the Stirling, until one or both can be mass produced; and the further development of the conventional Otto-cycle engine. The powerplants that were evaluated include: the uniform-combustion Otto engine, a stratified charge Otto, the diesel, the Brayton, the Rankine, the Stirling, and various hybrid.

Publ: Automotive Engineering v83 n12 p18-23, 57 (Dec 1975) 1975

Availability: See publication

HS-800 755

**DRUG ABUSE AND DRIVING PERFORMANCE. VOL. 2, APPENDICES B THROUGH F. FINAL REPORT**

Tabulated data on 1562 methadone maintenance patients in New York, and a control group of 1059 non-addicted people, relating to their driving records, is provided. Row data is converted into frequency tabulations. Each variable is defined at the top of the table and designated as either a row or column variable. Descriptions which include the word "abstract" or its abbreviation designate accident and violation data derived from the New York State Department of Motor Vehicles files. All variables without this designation or including the word "interview" (or "INTER.") in their label represent interview data, either direct responses to simple questions or a combination of the answers to two or more questions. The following time period designations are used: pre-drug (time before subject abused any drugs); non-heroin (during the time of abuse of non-opiate drugs); heroin (while using heroin, morphine or opium); and methadone (time of enrollment in a methadone maintenance treatment program).

by Richard D. Blomberg; David F. Preusser  
Dunlap and Assoc., Inc., One Parkland Drive, Darien, Conn. 06820

Contract DOT-HS-099-1-184

Rept. No. ED-72-23 ; 1972 ; 289p

Rept. for 30 Jun 1971-31 Oct 1972. Vol. 1 is HS-800 754.

Availability: NHTSA

HS-801 052

**CRASH INJURY REDUCTION AND POST-CRASH FACTORS EVALUATIONS. FORD ESV'S--FORTY MPH, FIFTY-MPH, AND LOW-SPEED BARRIER IMPACTS. FINAL REPORT**

The results of front and rear low-speed bumper tests and 40 and 50 mph frontal flat-barrier tests conducted on two Ford Experimental Safety Vehicles are presented. Vehicle damage was evaluated for the low-speed impacts and occupant (dummy) and structural response were determined for the front barrier tests. Post-crash factors evaluations were also performed to evaluate rescue and emergency egress. Each vehicle was equipped with five anthropometric dummies (three rear, and two front seat) and was instrumented with accelerometers, microphones, pressure transducers, and other devices. Eighteen high-speed cameras were utilized for crash recording: 11 for vehicle dynamics and 7 for dummy dynamics. The two vehicles both had elaborate energy absorbing structures (a corrugated collapse apron, and front and center rail energy absorbers) and both were equipped with front and rear air bag restraint systems. The front and rear bumper systems functioned as designed (little or no damage at 10 mph). In the 40 mph front barrier test the residual crush was 23.4 inches, the dynamic crush was 33.2 inches, and the occupant compartment intrusion was 0.5 inch. Average acceleration calculated from the impact speed and displacement equaled 18.7 G. All dummies were found in an upright position and head and chest injury criteria were not exceeded. Both rear doors were opened easily and both front doors were opened with moderate effort using a crowbar after the test. In the 50 mph test: residual crush was 33 inches, dynamic crush was 43.7 inches and occupant compartment intrusion was 5 inches; the rear air bag suffered a seam failure causing a failure in the front seat from rear occupant loading; none of the dummies met all occupant injury criteria; and all four doors were jammed shut. Head, chest, and pelvis accelerations severity index, and femur loads are tabulated by seating position. Impact data are shown for the involved vehicles, and photographs of vehicle damage are included.

Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle Peak Rd., Phoenix, Ariz. 85027

Contract DOT-HS-046-2-468

Rept. No. 2310-73-116 ; 1974 ; 222p

Report for Apr-Jun 1973.

Availability: NTIS

HS-801 125

**DRIVER IMPROVEMENT TRAINING AND EVALUATION. FINAL REPORT**

A total of 3,266 young male United States Coast Guard recruits (17-25 years of age) were included in a 30-month study to determine the driving-behavior-improvement potential of driver training programs and to identify which training method--classroom and driving range training, classroom-only training, or range-only training--is most effective. The conceptual model developed was comprised of five sequential functions: diagnosis; assignment to training; conduct of training; evaluation through intermediate criteria measures of driving attitude, knowledge, and skills; and evaluation through ultimate criteria measures of violations and accidents. The data collection instruments used are described: baseline instruments (driving history and biographical questionnaires and psychological tests); intermediate criteria measures (attitude, knowledge,



and driving range tests); and ultimate criteria measures (behavioral questionnaires and follow-up analysis of post-training driving records). While pre-test data revealed no significant differences between the experimental (those involved in some form of training) and control groups, analysis of the post-test data indicated that the experimental groups performed significantly better on the driver knowledge test and on the driving range test than the control groups.

by John A. Whittenburg; Robin S. McBride; Richard F. Pain; Gail L. Baker  
American Univ., Devel. Education and Training Res. Inst.,  
2139 Wisconsin Ave., N.W., Washington, D.C. 20007  
Contract DOT-HS-133-1-200  
1974 ; 446p refs  
Report for Jun 1972-Jun 1973.  
Availability: NTIS

HS-801 382

### PERISCOPE DEVICE FIELD EVALUATION BY GOVERNMENT DRIVERS

A nationwide field study of a periscope device installed on 50 government cars, conducted over an 18 month period beginning in October 1971, is reported. The ten field test sites were: Boston, Massachusetts; Washington, D.C.; Cape Kennedy, Florida; Detroit, Michigan; Duluth, Minnesota; Kansas City, Missouri; Albuquerque, New Mexico; Los Angeles, California; Salt Lake City, Utah; and Seattle, Washington. The 3-mirror, over-the-top viewing system was evaluated by 726 federal employees over one-third of a million miles. The drivers were predominately male and about 45% of those who returned the test questionnaires that were sent out were 40 years old or older. From questionnaire response analysis it is concluded that: in general, the periscope design was well received, and the longer the device was used the better it was liked; most negative comments were concerned with view limitations caused by adverse weather conditions; drivers liked the increased information about the rearward traffic scene; and there appears to be no reason why the driving public could not adapt to and effectively use a periscope device.

by Charles H. Kaehn  
National Hwy. Traffic Safety Administration, Office of Crash Avoidance, Washington, D.C.  
1975 ; 12p 4refs  
Availability: Corporate author

HS-801 708

### ALCOHOL SAFETY ACTION PROJECTS EVALUATION OF OPERATIONS--1974. VOL. 2: DETAILED ANALYSIS. CH. 6: EVALUATION OF THE PUBLIC INFORMATION AND EDUCATION COUNTERMEASURE ACTIVITIES

The public information and educational activities of the Alcohol Safety Action Projects (ASAP) are evaluated in terms of objectives and results. Objectives of the public information and educational efforts during the third year of ASAP operation include: the dissemination of knowledge about the ASAP program and about the effects of alcohol on driving and traffic safety; the development of responsible public attitudes toward the problems of drinking and driving; the stimulation of behavior patterns rejecting mixing alcohol and driving; the development of public support for ASAP programs; and the

management of media programs and other educational efforts directed at these problems. Target audiences which have been selected by various ASAP projects include: bar patrons; package store patrons; legislatures; police; physicians; and youth. Creative strategies used in the public information programs have included the use of fear, humor, endorsements, situational formats, and hostess packages for publicizing the problem. Community support for ASAP programs has come from businesses, churches, volunteers, and civic groups. Household surveys and roadside surveys have been used to evaluate the public information and educational effort. Examples of public information campaigns conducted by several ASAP projects are included. It is concluded that the evaluation of ASAP public information and education efforts indicates that they have achieved a significant impact in making positive changes on knowledge, behavior, and attitudes with regard to alcohol and driving questions. The greatest success has been achieved in the area of providing accurate information about the causes, severity, and consequences of the alcohol/driving problem. An example of a communications plan submitted by the Washtenaw County, Michigan, ASAP, and aggregate data from ASAP household survey core questions used in evaluating information and educational efforts are appended.

National Hwy. Traffic Safety Administration, Washington, D.C.  
1975 ; 62p 5refs  
Ch. 1 is HS-801 726; ch. 2 is HS-801 727; ch. 3 is HS-801 709; ch. 4 is HS-801 728; and ch. 5 is HS-801 729.  
Availability: NHTSA

HS-801 709

### ALCOHOL SAFETY ACTION PROJECTS. EVALUATION OF OPERATIONS--1974. VOL. 2: DETAILED ANALYSIS. CH. 3: EVALUATION OF THE JUDICIAL AND LEGISLATIVE COUNTERMEASURE ACTIVITIES

The judicial and legislative countermeasure activities included in the Alcohol Safety Action Projects (ASAP) are discussed. The overall objectives of these activities are to: inform the participants in the criminal justice system of the extent and nature of the drinking and driving problem; obtain the active support and participation of judges and prosecutors at the ASAP sites; assist in the development of a rapid and efficient processing system for drinking and driving cases that insures a high rate of convictions and protects the constitutional rights of each defendant; and assist the courts and prosecutors by providing resources and expertise to assist them in identifying the drinking status of persons convicted of driving while under the influence (DUI's) and referring them to appropriate rehabilitation programs. To achieve these goals, ASAPs took the following steps: obtained the cooperation of judges and prosecutors; achieved increased flexibility in sentencing; simplified evidence requirements; achieved support for and provided assistance in presentence investigations; identified and assisted referral agencies; effected the use of rehabilitation and retraining facilities; and secured community support for court and court officials. All of the 29 presently existing ASAP's have been openly engaged in promoting the passage of alcohol and drug legislation by their respective state legislatures that will best serve the interests of the ASAP concept. Punitive sanctions have been used both to encourage participation in rehabilitation programs and to deter drunk driving. The judicial activities of ASAP's are evaluated by the proportion

of the total adjudicated DUI cases having satisfactory outcomes. A disposition was considered satisfactory if: it provided an incentive for participation in a rehabilitation program; it had a deterrent effect on the subsequent drinking-driving behavior of social drinkers; and the alcohol related offense was placed on the individual's driving record. Information from 24 ASAP sites indicates that while all sites except one showed an increase in the percentage of alcohol-related arrests, several experienced decreases in conviction rates and/or dismissal rates. All 24 sites had some arrestees entering a rehabilitation program and conducted presentence investigations on from 4 to 100% of them.

National Hwy. Traffic Safety Administration, Washington, D.C.

1975 ; 40p

Ch. 1 and 2 are HS-801 726 and 801 727; ch. 4 and 5 are HS-801 728 and 801 729; and ch. 6 is HS-801 708.

Availability: NHTSA

#### HS-801 725

### **TRAFFIC SAFETY PROGRAMS CONTRACTS. RESEARCH AND DEVELOPMENT, DEMONSTRATIONS, MANPOWER DEVELOPMENT. FY 1975-FY 1976**

A listing of traffic safety program contracts granted by the National Highway Traffic Safety Administration for fiscal year 1975-76 is presented. Information presented for each contract includes: the program code; the title of the contract; the name of the contract technical manager; the amount; the expected date of completion; and a brief summary of the purpose of the contract. Research and development contracts have been grouped into the following subject categories: alcohol; drugs; pedestrian and bicyclist safety; seat belt usage; driver education; driver licensing; motorcycle/bicycle; safety driving conformance; accident investigation; mathematical analysis; information and data systems; and vehicles in use. Contracts for demonstrations include: alcohol safety action projects; advanced countermeasure experiments; advanced countermeasure support; alcohol public education; traffic enforcement; driver programs; systems operations; pedestrian and motorcycle safety; emergency medical services; National Driver Register; state records and information systems; and Highway Safety Act studies. Manpower development contracts involve the development of training materials and programs for court personnel, emergency medical service program administrators, accident investigators, highway safety officials, driver education instructors, persons involved in probation diagnosis and referral, police, and others.

National Hwy. Traffic Safety Administration.

1975 ; 67p

Availability: NHTSA

#### HS-801 726

### **ALCOHOL SAFETY ACTION PROJECTS. EVALUATION OF OPERATIONS--1974. VOL. 2: DETAILED ANALYSIS. CH. 1: ASAP PROGRAM EVALUATION METHODOLOGY AND OVERALL PROGRAM IMPACT**

Problems associated with the ultimate Alcohol Safety Action Project (ASAP) impact can be divided into three general categories: validity of criterion measures to be used to mea-

sure the impact; appropriate evaluation design selected; and appropriateness of the statistical tests used for hypothesis testing. The key problem involved in evaluating the validity of criterion measures is the isolation of a valid measure of the alcohol involvement in crashes. The measures generally available for this purpose have been: the blood alcohol concentration of fatally injured drivers; the judgment of the police officer investigating the accident that the driver was impaired by alcohol; and the time of day at which the accident occurred. An adequate research plan to evaluate the overall impact of the ASAP must be designed to reject all alternate hypotheses for a downward trend in accidents. Interrupted time series analysis techniques and simultaneous time series analysis can be used to determine the ultimate impact at either the project or program level, eliminating most threats to the validity of the pretest-posttest research design. Determination of the effectiveness of individual countermeasures and assessment of the project impact involves: assessment of the changes in ultimate performance measures; assessment of changes in proxy measures of project impact; cost effectiveness of the ASAP project; and a comparison of the profiles of fatally injured drivers and driving while intoxicated (DWI) arrests by ASAP patrols. Summaries of the results of 29 individual ASAP projects at the local, regional, and state level, as reported in the analytic studies by the sites themselves, are included. Since most alcohol related accidents occur in the evening and night hours, it is felt that fatal night crash data can be used as a valid measure of project or program impact. For the average of the baseline period, it appears that daytime fatal crashes were up about 1% while night fatal crashes were down about 2%. An analysis of total fatal crash differences for the 29 projects for the two operational years shows that night fatal crash differences for the latest baseline year were down 111 while day fatal crashes were up 64. Comparison of the blood alcohol concentrations of drivers tested during roadside surveys conducted at several of the ASAP project sites indicated that the ASAP program has had an impact on the social drinker-driver, but has had very little impact on the drinking driver who drives at blood alcohol concentrations greater than 0.10.

National Hwy. Traffic Safety Administration, Washington, D.C.

1975? ; 50p 4refs

Ch. 2 is HS-801 727; ch. 3 is HS-801 709; ch. 4 is HS-801 728; ch. 5 is HS-801 729; and ch. 6 is HS-801 708.

Availability: NHTSA

#### HS-801 727

### **ALCOHOL SAFETY ACTION PROJECTS. EVALUATION OF OPERATIONS--1974. VOL. 2: DETAILED ANALYSIS. CH. 2: EVALUATION OF THE ENFORCEMENT COUNTERMEASURE ACTIVITIES**

Enforcement of driving under the influence (DUI) laws constitutes the input factor of the Alcohol Safety Action Plan (ASAP) system concept, whose goals are to identify, apprehend, and channel offenders into the judicial system and to optimize the level of effort directed at this activity in order to instill a high perception of risk of being apprehended in potential drinking drivers. The ASAP concept places the highest priority on increasing the arrest rate. In most ASAP projects special enforcement task forces have been instituted to patrol at peak drinking-driving periods. Attempts have also been made to increase the arrest rate for DUI offenses. The major objective of the enforcement countermeasure is to increase detec-

tion and apprehension for alcohol-related traffic offenses, which are defined to include: driving while under the influence of alcohol; driving with a blood alcohol concentration (BAC) of 0.10 or more; and driving while ability is impaired by alcohol. Other objectives of the countermeasure are to improve the conviction rate for alcohol-related offenses and to improve the detection and apprehension rate of those drivers who are operating vehicles when their driving privileges have been suspended due to an alcohol-related traffic offense. Personnel assignments, patrol strategies, arrest procedures, and special equipment used in the enforcement procedures used by the ASAP's are described. Summaries of the enforcement activities at each of the 30 ASAP projects are presented. It is concluded that no simple relationship between enforcement and accidents has been established in the ASAP projects. In several instances, fourfold and fivefold increases in arrests have not been able to have an impact on the crash level. One possible explanation is that the target population has not yet perceived the increased chances of driving while intoxicated. While a few projects have been able to detect an increase in the population's fear of arrest, this has generally been associated with a concentrated public information effort. Another possible explanation is that the new enforcement levels, although at an all time high, are still below the threshold needed to directly have an impact on accidents.

National Hwy. Traffic Safety Administration, Washington, D.C.  
1975? ; 51p  
Ch. 1 is HS-801 726; ch. 3 is HS-801 709; ch. 4 and 5 are HS-801 728 and 801 729; and ch. 6 is HS-801 708.  
Availability: NHTSA

HS-801 728

**ALCOHOL SAFETY ACTION PROJECTS.  
EVALUATION OF OPERATIONS--1974. VOL. 2:  
DETAILED ANALYSIS. CH. 4: EVALUATION OF  
THE PRESENTENCE INVESTIGATION AND  
PROBATION COUNTERMEASURE ACTIVITIES**

The presentence investigation (PSI) and probation countermeasure activities of the Alcohol Safety Action Projects (ASAP) are evaluated. The ultimate product of PSI is a recommended disposition for each offender ranging from traditional penal sanctions to the most intensive rehabilitative treatment available. Presentence investigation involves the use of the previous recorded history of the driver, medical and/or psychological symptoms of problem drinking, and self-report information. All of the ASAP projects perform some type of evaluation of the offender's drinking problems and all use the information as a basis for reporting the individual for further treatment. ASAP probation officers are responsible for maintaining follow-up contact with offenders placed on probation by the courts. Evaluation of the effectiveness of PSI involves analysis of the volume of PSI activity; presentence investigations as a function of arrests and convictions; the validity of drinker classification, court cooperation, and costs for the program. Data are presented on the PSI activities of several ASAP projects. The most valid and efficient PSI tools are: the Mortimer Filkins test score, which involves use of an interview and a questionnaire; blood alcohol concentration at the time of arrest; and driver and arrest records. It appears that the point at which the PSI takes place in the adjudication process is not as important as that the information obtained be used to make the most appropriate disposition of the case.

National Hwy. Traffic Safety Administration, Washington, D.C.  
1975? ; 22p 27refs  
Ch. 1 and 2 are HS-801 726 and HS-801 727; ch. 3 is HS-801 709; ch. 5 is HS-801 729; and ch. 6 is HS-801 708.  
Availability: NHTSA

HS-801 736

**NONDESTRUCTIVE TESTING SYSTEM FOR  
RETREADS. FINAL REPORT**

An air-coupled through-transmission ultrasonic inspection system for finding anomalies in tire casings is described. Descriptions of components, characteristics, functions, installation, operation, and maintenance for the system are provided. A tabular listing of the component parts of various circuit boards, frames, and chassis for the system and relevant photographs are included. The system is described in sufficient detail to permit its reproduction by a reasonably competent electronics manufacturer.

by Henry H. Bessler; Stephen N. Bobo; Manuel J. Lourenco; William R. Wade  
Department of Transportation, Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142  
Rept. No. DOT-TSC-NHTSA-75-4 ; 1975 ; 92p  
Report for Jul 1974-Oct 1975.  
Availability: NTIS

HS-801 740

**MOTOR VEHICLE SAFETY DEFECT RECALL  
CAMPAIGNS REPORTED TO THE NATIONAL  
HIGHWAY TRAFFIC SAFETY ADMINISTRATION  
BY DOMESTIC AND FOREIGN VEHICLE  
MANUFACTURERS, JULY 1 1975 TO SEPTEMBER  
30, 1975**

This tabulation of safety defect recall campaigns includes the make and model, model year, description of the defect requiring manufacturer's corrective action, number of vehicles recalled, date of notification, and identification number. Automobiles, trucks, buses, trailers, tractors, motor homes, wheels, motorcycles, engines, fire engines, ambulances, tires, axles, and braking systems are included. The status of domestic and foreign campaigns completed as of September 30 is also given.

National Hwy. Traffic Safety Administration, Washington, D.C.  
1975 ; 41p  
Availability: AV: NTIS; GPO

HS-801 748

**TEST EVALUATION OF THIOKOL INFLATORS FOR  
AIR CUSHION RESTRAINT SYSTEMS. FINAL  
REPORT**

The original equipment inflators were removed from both the driver and passenger air cushion restraint systems of four 1975 Oldsmobile 98's. Pyrotechnic inflators built by the Thiokol Corporation were installed in their place. Three of the automobiles (instrumented with accelerometers and pressure transducers) were then subjected to fixed barrier crash tests at speeds

May 31, 1976

HS-801 758

of 35-40 mph. Injury levels were determined on 50th percentile dummies (instrumented with accelerometers and femur load cells) occupying the front seats, and compared with the injury criteria of Federal Motor Vehicle Safety Standard (FMVSS) 208. A 6-year-old child dummy (instrumented with accelerometers) was placed out-of-position on the front passenger seat of the fourth automobile and the bag was statically deployed. Injury levels were determined for the child dummy and compared with the criteria of FMVSS 208. Six 16 millimeter high-speed cameras were located on and around the impact barrier facility, as well as inside the vehicle, to provide total viewing of the vehicle impact, and data on dummy retention within the vehicle. Although the test sample size was small, the Thiokol pyrotechnic inflator air cushion restraint system appears to offer an increase in crash protection especially at higher impact speeds.

by E. Enserink  
Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle  
Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-5-01104  
Rept. No. 3942-75-159 ; 1975 ; 205p  
Report for Apr 1975-Oct 1975.  
Availability: NTIS

HS-801 753

#### **INVESTIGATION OF TEST PARAMETERS AFFECTING FLEXION PROPERTIES OF PART 572 DUMMY NECK, LUMBAR SPINE, AND ABDOMEN. FINAL REPORT**

The results of tests conducted to investigate the rate dependency of abdomen and lumbar calibration tests as specified by Federal Motor Vehicle Safety Standard (FMVSS) 208 are presented. Neck flexure tests were performed with different necks, head skins, and centers of gravity to determine the extent to which neck skin to pendulum contact affects neck flexion performance. Lumbar spine flexion tests included flexion of the lumbar spine at constant application rates of 1 degree per second, 3 degrees per second, and 6 degrees per second, then holding at maximum flexion for 10 seconds and releasing. Abdomen flexion tests include constant deflection rates at .05, .1, and .3 inch per second. Six 50th percentile male dummies were used. Photographs of the test equipment are provided. Recommendations for changes in the test procedures specified in Part 572 of the Code of Federal Regulations are presented.

by E. Enserink; C. Bonelli  
Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle  
Peak Rd., Phoenix, Ariz. 85027  
Contract NHTSA-5-1538  
Rept. No. 6910-75-68 ; 1975 ; 74p  
Report for Sep 1974-May 1975.  
Availability: NTIS

HS-801 754

#### **ANTHROPOMORPHIC DUMMY POSITIONING REPEATABILITY, AND STABILITY TESTS. FINAL REPORT**

The part 572 (50th percentile male) anthropomorphic dummy was used to evaluate the performance of automobile passive restraint system built to meet the requirements of Federal Motor Vehicle Safety Standard (FMVSS) 208. The vehicles used (16 in all) were selected to represent the full range of

designs being produced. Two dummies from each of three manufacturers were used. Repeatability tests, consisting of positioning the dummy in the vehicle and recording the pertinent dimensions which define the position, and stability tests, placing the dummy in the vehicle, recording its position, accelerating the vehicle at 0.25 to 0.50 G to 30 mph, slowing it to a stop, and measuring the position shift due to vehicle motion, were conducted. In the stability testing, 54 acceleration runs were made using nine vehicles with six runs per vehicle. Vehicle propulsion was provided by two 390 cubic inch V-8 engines driving a winch system. A block diagram of the acceleration run instrumentation system is provided. Dummy positioning fixtures included a hoist, a load applicator, and a point measurement gauge. Positioning procedures are discussed and photographs are provided. Testing results enable a dummy positioning procedure which increases stability and provides for more definitive placement in different size vehicles to be recommended.

by C. Bonelli; E. Enserink  
Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle  
Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-046-5-1030  
Rept. No. 6510-75-98; 1975 ; 124p  
Rept. for Dec 1974-Mar 1975.  
Availability: NTIS

HS-801 758

#### **FIELD OF VIEW WITH AND WITHOUT MOTORCYCLE HELMETS. FINAL TECHNICAL REPORT**

The total field of view for 19 experienced motorcyclists (18 male, 1 female) at 10 angular positions was obtained by moving a target along a circular perimeter and recording the angle at which it was first perceived. A four foot radius perimeter device, made from welded rolled aluminum sections and extending 127° from the center of rotation, was used. The seat structure provided for adjustable subject height and chin support. The target that the subjects observed entering their field of view was a white dot on a block trolley device. All subjects were tested with no helmet, two full coverage helmet models, two full facial coverage helmet models, and goggles. Photographs of the entire test apparatus with seated subjects are provided. It was found that: along the horizontal plane, visual restriction was less than 3% with full coverage helmets as compared to no helmet; the full facial coverage helmets produced 7.3% and 21.9% lateral field reduction; the helmet with the large restriction was a "worst case" helmet representing a small percentage of helmet sales and typically used in off-street situations; and lateral vision with goggles was about equivalent to that achieved by the most restrictive helmet.

by Stephen Gordon; James Prince  
National Hwy. Traffic Safety Administration, Safety Res.  
Lab., 6501 Lafayette Ave. Bldg. 2, Riverdale, Md. 20840  
1975 ; 27p  
Rept. for Jul-Oct 1975.  
Availability: NTIS

HS-801 759

HSL 76-05

HS-801 759

### **EFFECT OF SAFETY HELMETS ON AUDITORY CAPABILITY**

The phenomenon of hearing is examined to show that motorcycle helmets do not reduce auditory capability to a level unsafe for driving. The noise generated by the motorcycle itself (or wind, at higher speeds) is so great that any sound loud enough to penetrate this noise is loud enough to be heard inside a helmet. Basic human auditory capability and the direct effect of helmets on the auditory threshold are discussed. The effect of ambient noise on the auditory performance is also analyzed. Graphs are provided for: human auditory sensitivity to sounds of different frequencies; a comparison of average sound attenuation characteristics of automobiles (windows up) and protective helmets; a comparison of age-related hearing loss (ages 46-55) and temporary hearing loss from wearing protective helmets; the auditory threshold for the 46-55 age group with and without protective helmets; a comparison of motorcycle noise at various speeds and auditory threshold of 46-55 age group with and without helmets; illustrations of the masking of an automobile horn and a siren by motorcycle noise; and horn audibility inside a passenger car. It is concluded that: safety helmets have an inconsequential auditory effect because they reduce the loudness of both the sound of interest and the motorcycle noise by an equal amount and hence do not alter the signal-to-noise ratio between the two; and a helmeted motorcycle rider can hear a sound of interest about as well as a person in an automobile with the windows closed.

by Robert L. Henderson  
National Hwy. Traffic Safety Administration, Office of Driver and Pedestrian Res.  
1975 ; 18p 3refs  
Availability: NHTSA

HS-801 766

### **THE DRIVER EDUCATION EVALUATION PROGRAM (DEEP) STUDY. A REPORT TO THE CONGRESS**

The National Highway Traffic Safety Administration (NHTSA) has taken the position that a quality High School Driver Education (HSDE) program is capable of a 10-15% effect in terms of reducing the probability of crash involvement among persons exposed to it. The process of evaluating the driver education programs, the Driver Education Evaluation Program (DEEP), is reported in detail. The potential target groups for driver education efforts, their contribution to highway crashes, and the particular problem characteristics of each group are discussed: young drivers, male and female, and their crash records and problems; elderly drivers; motorcycle operators; problem and near-problem drivers; drinking drivers; and all drivers. A brief description of the implementation history of HSDE programs and a summary of past attempts to evaluate such efforts are provided. Major problems involved in the evaluation of HSDE programs are discussed and major non-NHTSA driver education activities (for adult, elderly, drinking, and handicapped drivers) are reported. NHTSA's efforts within the HSDE area and the broader traffic safety education area are described. Findings and recommendations for future efforts in these areas covering both evaluation program development efforts for both NHTSA and state programs are presented.

National Hwy. Traffic Safety Administration  
1975 ; 104p 149refs  
Availability: NHTSA

HS-801 767

### **RESEARCH SAFETY VEHICLE (RSV). PHASE II. STATUS REPORT NO. 2, 16 SEPTEMBER TO 16 NOVEMBER 1975**

The progress in development of a research safety vehicle (RSV) by Calspan Corporation for the National Highway Traffic Safety Administration is reported at a time when the structural design in support of the initial crush test series is 90% complete. Revisions in the front structural force-deflection properties have been investigated relative to structure and restraint system performance. Preliminary vehicle-to-vehicle impact simulation results using static crush data are compared to crash test data, and pedestrian impact simulations are reported. Details of rear structural design and studies of vehicle ride, steering geometry, and handling characteristics are discussed. Extensive occupant model simulations were performed and both the advanced belt airbag simulations provided encouraging results in relation to the performance expectations of the RSV. Both crush and crash tests were performed: two side crush tests where loading was above the sill in one case and completely engaged the sill in the other; and 40 mph frontal off-set and two vehicle-to-vehicle side impacts. The major areas of the producibility effort are discussed: general analysis of domestic and worldwide material resources; preliminary analysis of the impact an RSV would have on these resources; and determination of the recycling potential for the RSV.

Calspan Corp.  
Contract DOT-HS-5-01214  
Rept. No. PR-2 ; 1975 ; 125p refs  
Availability: Reference copy only

HS-801 768

### **ADVANCED PASSIVE RESTRAINT SYSTEM FOR SUBCOMPACT SIZE VEHICLE FRONT SEAT PASSENGERS. PROGRESS REPORT NO. 16, 6 OCTOBER 1975 TO 2 NOVEMBER 1975**

A final sled test series (16 runs) in the development of an advanced passive restraint system for subcompact size vehicle front seat passengers is reported. The adult dummy size, 5th percentile female, and 50th and 95th percentile male, were tested in the normal seated position at 42 and 48 mph and the 6 year old child size was tested in the forward position, statically, at 32 and 48 mph. The child dummy was also tested in the normal seated position at 32 mph and 48 mph. All tests were conducted at a zero degree impact angle. Detailed results of the tests and photographs of the runs are presented. It was found that: from the static test results the system can be expected to function (for the 50th percentile male dummy) regardless of the deployment angle or bag stowage used; the plus 10 degree deployment angle was the best system condition for the 6 year old child size dummy; forward position child results were significantly improved with the bag folded all-down; windshield contact was an acceptable condition of the system; adequate restraint for the 95th percentile male dummy was provided to 43 or 44 mph; for the 5th percentile female a velocity capacity of 48 mph was shown; the child results in the forward position were excellent at all velocities.

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HS-801 774

conditions; and in the normally seated position child results were well within injury criterion limits at 32 mph but not at 47 mph.

by David J. Romeo  
Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221  
Contract DOT-HS-4-00972  
Rept. No. PR-16 ; 1975 ; 15p  
Availability: Reference copy only

HS-801 769

**DIAGNOSTIC ASSESSMENT OF DRIVER PROBLEMS: VOLUME I. THE STATE-OF-THE-ART IN DRIVER PROBLEM DIAGNOSIS. FINAL REPORT**

A review of traffic safety literature was conducted to evaluate the potential of assessment techniques for identifying driver problems with the ultimate objective of providing operational assessors with techniques useful for such identification. The state-of-the-art review was organized by levels of observation: Level I was defined as assessment primarily available from a driver licensing file; Level II included data from other agencies; and Level III contained information directly obtainable from the driver. Each level was further divided by conceptual area: performance, biographical, psychological/social/attitude, medical/physiological, and exposure. A critical analysis of the research literature identified several inherent methodological any firm conclusions on the utility of techniques. Level I data sources were demonstrated to have the greatest current utility for diagnostic assessment in an operational setting, based on the relatively inexpensive means of data retrieval and the consistency of significant predictors found at this level. A prototype model based on an assimilation of the research reviewed was developed to provide guidelines for assessment in operational settings.

by Robin S. McBride; Kenneth W. Stroad, Jr.  
Human Resources Research Organization, 300 North  
Washington St., Alexandria, Va. 22314  
Contract DOT-HS-4-01015  
Rept. No. HumRRO FR-ED-75-21-Vol-1 ; 1975 ; 412p refs  
Rept. for 28 Jun 1974-31 Aug 1975. Vol. 2 is HS-801 770.  
Availability: NTIS

HS-801 770

**DIAGNOSTIC ASSESSMENT OF DRIVER PROBLEMS: VOL. 2. ASSESSMENT TECHNIQUES FOR OPERATIONAL USERS. FINAL REPORT**

A state-of-the-art literature review was conducted to identify diagnostic assessment techniques for identifying driver problems. Current systems generally employ some variation of "point count" or other criteria to define a driver as a problem or negligent. However, such an approach does not address the specific problems of the driver, nor does it provide guidelines for directing the driver to some form of treatment. A prototype model assessment system, based on the most useful techniques found in the research reviewed, was developed to provide these guidelines for assessment in operational settings. A critical analysis of the literature identified several inherent methodological problems which make it difficult to draw firm conclusions on the utility of various techniques. The literature on the assessment of driver problems has demonstrated that although numerous variables are related to driving performance, overall prediction is nevertheless limited. As a tool,

the diagnostic assessment process consists of collecting information which may eventually be used to direct a driver to some form of rehabilitative effort or to impose some form of sanction. A diagnostic approach should be flexible enough to be useful to a judge or driver improvement analyst with limited resources, yet should contain provisions for more in-depth assessment. The primary components of the proposed diagnostic assessment model are: the driver profile, which is a data collection instrument; scoring keys for the driver profile; a problem assessment guide, which enables determination of the type and extent of driver problem based on the scored responses; and a potential countermeasure assignment guide, which allows selection of the most appropriate treatment. With adequate resources, diagnostic assessment of driving problems can be implemented in any driver control setting. All state licensing agencies currently have the potential to conduct diagnostic assessment. Scoring keys and driver problem assessment guides for various age groups (both sexes) are appended.

by Robin S. McBride; Kenneth W. Stroad, Jr.  
Human Resources Res. Organization (HumRRO) 300 North  
Washington St., Alexandria, Va. 22314  
Contract DOT-HS-4-01015  
Rept. No. HumRRO-FR-ED-75-21-Vol-2 ; 1975 ; 186p 18refs  
Report for 28 Jun 1974-31 Aug 1975. Vol. 1 is HS-801 769.  
Availability: NTIS as PB-247 749

HS-801 774

**MATERIALS DEVELOPMENT FOR LEGISLATORS' SEMINAR IN ALCOHOL AND HIGHWAY SAFETY. FINAL REPORT**

An instructional seminar on alcohol and highway safety for state and local legislators has been developed, tested, and evaluated. A materials package designed for use in these seminars includes an Administrator's Guide, an Instructor's Guide, and a Participant's Manual. Two official pilot tests of the materials were conducted: a seminar in Maryland attended by seven legislators and a seminar in Iowa attended by 14 persons. Positive reactions by the participants in each of these seminars indicated that the project was successful in raising the legislators' consciousness of the alcohol/highway safety problem. More than half of all attending legislators stated that they would sponsor the package of laws projected in the 1972 proposed Standard No. 8. It is concluded that the seminar, as presently conceived, is the most effective way to communicate alcohol and highway safety information to state legislators. The Administrator's Guide outlines preparations and scheduling which are critical to seminar success. The use of a state-level agency director as host and the recruitment of "champions" in each legislative house is an absolute requirement. An optimal group of participants consists of 10 to 12 persons, but up to 18 legislators can be accommodated if the instructor is skilled in group dynamics techniques. The Instructor's Guide lists the qualifications which the seminar instructors must possess to carry out the tasks required in the seminar. It is recommended that some mechanism be instituted to obtain feedback from the states who choose to use the legislators' seminar package. Copies of the legislator questionnaire and the seminar evaluation form and a state-by-state listing of alcohol/highway safety legislation are appended.

HS-801 777

by Margaret W. Nesbitt  
Applied Science Associates, Inc., P.O. Box 158, Valencia, Pa.  
16059  
Contract DOT-HS-4-00985  
1975 ; 88p  
Report for Jun 1974-Sep 1975.  
Availability: NTIS

HS-801 777

**RESEARCH SAFETY VEHICLE (RSV). PHASE 2. BI-MONTHLY PROGRESS REPORT NO. 2, SEPTEMBER 17, 1975 TO NOVEMBER 16, 1975**

Full scale crash testing to date of this Research Safety Vehicle (RSV) has consisted of frontal barrier tests and side pole tests. Excessive intrusion into the passenger compartment occurred in the side pole tests. Two inflators for the restraint of the right front passenger have been fabricated and tested by static firings in a constant volume tank. A new steering column concept in which the energy absorption is accomplished via the roller tape mechanism, which involves pulling metal tape across a series of rollers which plastically deform the tape, has been fabricated for sled test purposes. The restraint system presently under development for the RSV right front passenger relies on the stroke of the airbag and forces limited stroking dash to absorb the kinetic energy of the passenger in frontal and frontal oblique impacts. Four sled tests have been conducted with the sled configuration of the driver restraint system using 50th percentile male driver surrogates in a simulated 50 mph frontal collision. Two sled tests have been conducted with the right front passenger restraint system using a 50th percentile humanoid dummy and a sled velocity of 39 mph. Computer simulations of sled testing of the rear seat restraint system have been conducted. Construction of a static crusher has been completed and a facility for testing two-car impact collisions is being constructed. The equipment of this latter test facility consists mainly of the crash pad and pit area, flanked by two 600 foot runways, each with a guide beam and tow system for vehicle to vehicle crash tests. Barrier impact capability will also be provided at this facility.

Minicars, Inc., 35 La Patera Lane, Goleta, Calif. 93017  
Contract DOT-HS-5-01215  
1975 ; 349p  
Rept. no. 1 is HS-801 778.  
Availability: Reference copy only

HS-801 778

**RESEARCH SAFETY VEHICLE (RSV). PHASE 2. BI-MONTHLY PROGRESS REPORT NO. 1, JULY 16, 1975 TO SEPTEMBER 16, 1975**

An experimental structure that is an assembly of numerous pieces spot-welded together is being used in the initial stages of the Research Safety Vehicle (RSV) project. The pieces are brake-formed and the welding is done with a wire-feed arc welder. This process results in the geometry of the components being somewhat different from what would be found in production and in differences in the quality of the individual welds. However, it permits the cheap fabrication of many structures, which in turn produces quick test results and early insight into geometrical relationships between the various components. The first build involves five structures, which are being utilized as follows: a configuration buck for preliminary engine, suspension, and upper structure locations; a sled test

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buck for the sled testing of restraint systems; a chassis structure only, for use in the study of foam-filling procedures and to be subjected to static crush tests; and a mandrel for constructing the interior/exterior buck. Two frontal impact models were implemented during this reporting period: an RSV rear-engine model using preliminary force-deflection properties, which was run for frontal barrier impacts of 50 and 70 mph, and a 1974 Pinto model, used for program verification. Test results indicate that a Chest Severity Index of 1,000 is reached at 50 mph in the RSV model and that a crush of 45 inches is reached at 56 mph. Four static crush tests were performed to obtain side structure strength data on existing vehicles in order to adequately design the RSV front end for the aggressivity requirement. A series of five foam-filled side sills of varying sheet metal thicknesses tested showed little effect on the skin thickness. Preliminary work on the development of restraint systems has included: a series of computer runs executed on the ABAG 19 program to explore the effects of the RSV pulses and the Thiokol inflator; initial work on the design of the steering column; and investigation of rear seat restraint systems, particularly a force-limited two-point airbelt system. Facilities for testing static crush and two-car crashes have been up-graded.

Minicars, Inc., 35 La Patera Lane, Goleta, Calif. 93017  
Contract DOT-HS-5-01215  
1975 ; 176p  
Rept. no. 2 is HS-801 777.  
Availability: Reference copy only

HS-801 781

**MARK II INTEGRATED DRIVER VISION TESTING DEVICE. FINAL REPORT**

The Mark II Integrated Driver Vision Testing Device was designed to measure a range of visual functions which may be related to driving accidents. The device automatically administers and scores eight vision tests: static acuity; dynamic acuity; detection, acquisition and interpretation; static acuity-low luminance; central movement in depth; angular movement; field; and static acuity with glare. The instructions, contained within the device, are primarily auditory, supplemented with visual signs and test stimuli keyed to the spoken message. Testing is adaptive, where the level of difficulty depends on the subject's performance on previous trials. Scoring is automatic with the results being immediately available. The instructions have been improved so that there are very few failures due to lack of understanding. The difficulty levels of each test have been adjusted so that discriminations can be made between poor performers. The test-retest reliabilities were found to be satisfactory, ranging from 0.50 to 0.87 for the eight tests. The overall reaction of the 255 people tested was highly positive. A pretest brochure and test instructions, the procedure for threshold measurement, the examiner's control operations, the hardware specifications (with drawings), and the software overview are appended.

by Leon G. Williams; Carl P. Graf  
Honeywell Inc., Systems and Res. Center, 2600 Ridgway Pkwy., Minneapolis, Minn. 55413  
Contract DOT-HS-4-00963  
1975 ; 121p 1ref  
Report for Jul 1974-Aug 1975. Supersedes HS-801 756.  
Availability: NTIS



May 31, 1976

HS-801 795

HS-801 784

### **UNIFORM TIRE QUALITY GRADING-- TREADWEAR. FINAL REPORT**

The purpose of this contract was to evaluate treadwear ratings on four specific groups of tires when tested on somewhat similar type courses at widely different geographic locations. A four car convoy of 1975 Chevrolet Chevelle Malibu four door sedans was run for 16,000 miles. The test route was the established 16,000 mile route yielding the desired 65% wear rate on the National Highway Traffic Safety Administration (NHTSA) control tires. One vehicle was equipped with these control tires, while the other three were equipped with specified candidate tires. The candidate tires tested were: Goodyear Custom Power Cushion Polyglas; Goodyear Power Cushion 78; and Goodyear Special. The following treadwear ratings were obtained from these tests: NHTSA control, 100%; Goodyear Custom Power Cushion Polyglas, 99.7%; Goodyear Power Cushion 78, 98.3%; and Goodyear Special, 83.5%. However, these ratings are based on the average wear for the four tires; the data spread within the tires comprising each group was found to be greater than the difference in the averages. Data are presented on the percent worn versus mileage for the test tires. Tire wear data sheets and test summary data sheets are included.

by James E. Shearer; Donald Scott McClure  
Compliance Testing, Inc., 1150 North Freedom St., Ravenna,  
Ohio 44266  
Contract DOT-HS-5-01047-1  
1975 ; 57p  
Report for May-Jun 1975.  
Availability: NTIS

HS-801 786

### **WARNING LIGHTS FOR SPECIAL PURPOSE VEHICLES**

State laws and regulations on vehicle lights and warning lights which must be used on certain special purpose vehicles in the traffic system are examined. While almost all vehicles are equipped with some types of warning lights, such as turn signal lights, stop signal lights, and vehicular hazard warning lights, only certain special function vehicles are normally equipped with additional warning lights which are distinct, primarily in terms of their color, mode of operation, size, or intensity. The use of additional warning lights on such special function vehicles is generally required, or at least specifically authorized, by law and the use of such lights on other vehicles is frequently prohibited. The Uniform Vehicle Code has prohibited the use of any red light visible to the front on any vehicle except as specifically authorized or required since 1926 and the use of flashing lights on any vehicle except as specifically authorized or required since 1934. State laws specifying

or restricting the use of warning lights and warning light color or color combinations on vehicles are summarized. Special warning lights are required for such authorized emergency vehicles as fire vehicles, police vehicles, and ambulances. Where private vehicles operated by firemen on official duty are designated as authorized emergency vehicles, these vehicles may also have the specified lights. Service vehicles which may be required or authorized to use special warning lights include: highway maintenance vehicles; tow vehicles; public utility vehicles; mail delivery vehicles; pilot vehicles and oversized loads; farm vehicles; funeral vehicles; and government vehicles. In some states, the following special vehicle types are required or authorized to use restricted warning lights: civil defense vehicles; civil air patrol vehicles; marshal's vehicles; coroners', doctors', and armored cars; paraplegics' vehicles; newsmen's, itinerant vendors', and commercial vehicles; church and worker transport buses; animal removal vehicles; and others.

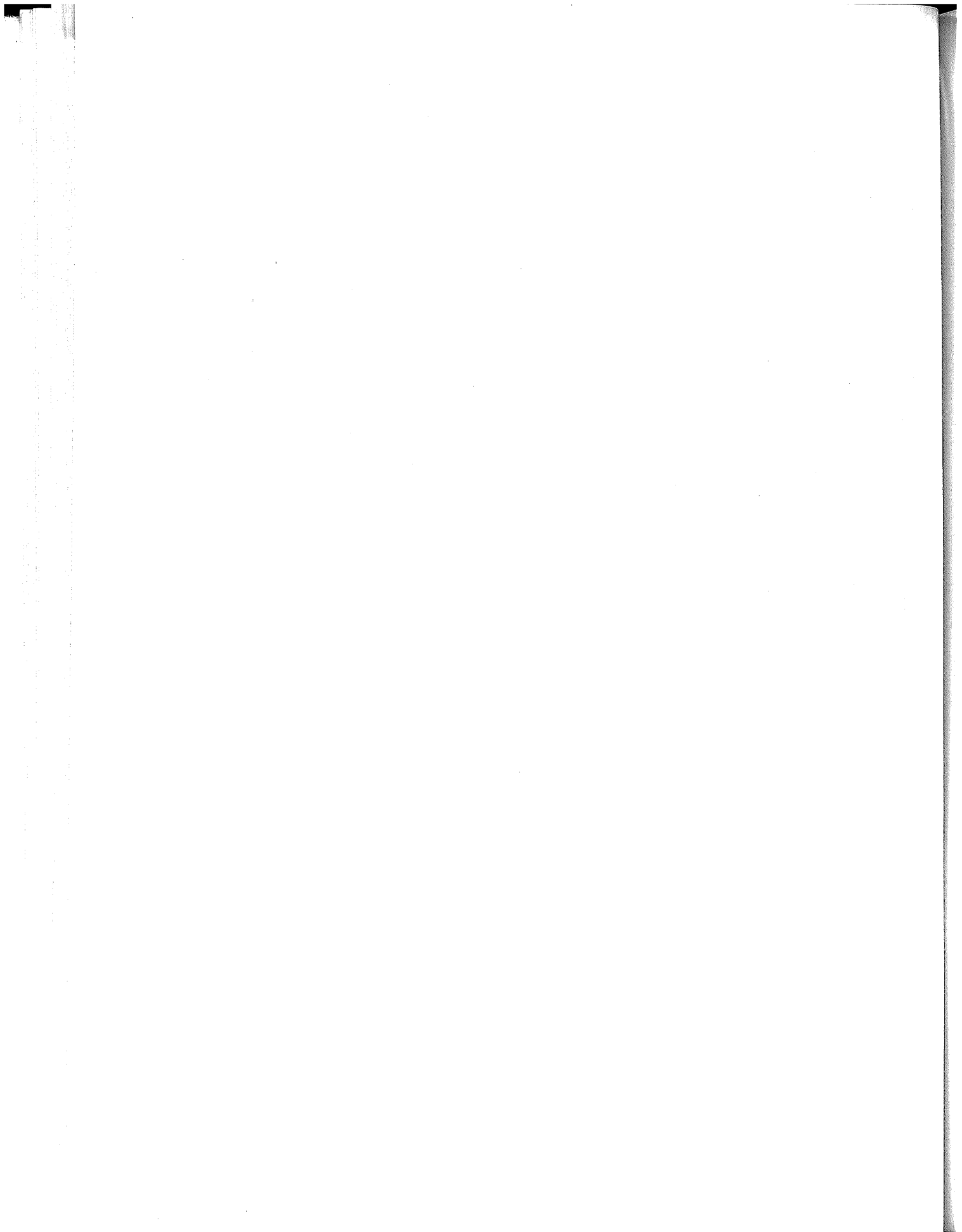
by John W. English; James H. Young; Howard B. Friedland  
National Com. on Uniform Traffic Laws and Ordinances,  
Suite 430, 1776 Massachusetts Ave., N.W., Washington, D.C.  
20036  
Contract DOT-HS-5-01121  
Publ: Traffic Laws Commentary v4 n3 p1-84 (Dec 1975)  
1975 ; 12refs  
Availability: Corporate author

HS-801 795

### **SAFETY BELT INTERLOCK SYSTEM USAGE SURVEY. MONTHLY PROGRESS REPORT NO. 11**

Progress which has been made on a U.S. Department of Transportation contract dealing with the usage of the safety belt interlock system is reported. Telephone interviews have been completed with 614 owners and drivers of 1975 model cars. Some of these cars were equipped with working interlock systems, while other of the cars were shipped with the interlock disconnected but with a buzzer and light warning system. Interview data shows that 47% of those interviewed having the interlock system almost always used the safety belt, while only 37% of those with the warning system did so. Of those with the interlock system, 31% said the 1975 system has increased use of the safety belt, while only 16% of those with the warning system experienced increased use. The results of survey questionnaires used with 2,198 Volkswagen passive belt owners and 561 Volkswagen active belt owners have been tabulated and analyzed. Current observation data showing results by month, sex of driver, manufacturer, and seat type are included in this report. Data are based on observations conducted during the period February 1974 through June 1975.

by Albert Westefeld  
Opinion Res. Corp., North Harrison St., Princeton, N.J. 08540  
Contract DOT-HS-5-01039  
Rept. No. PR-11 ; 1975 ; 8p  
Availability: Reference copy only



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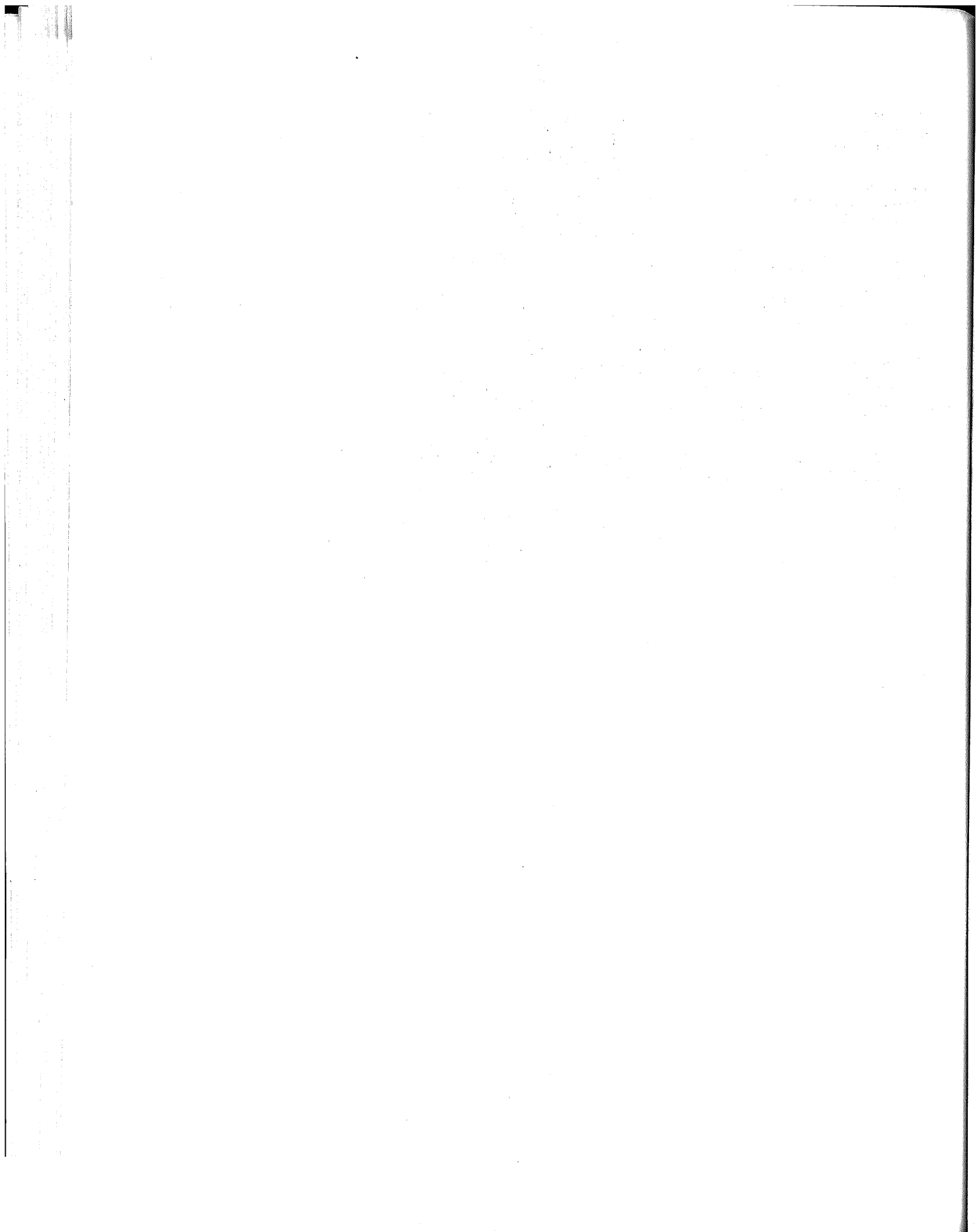
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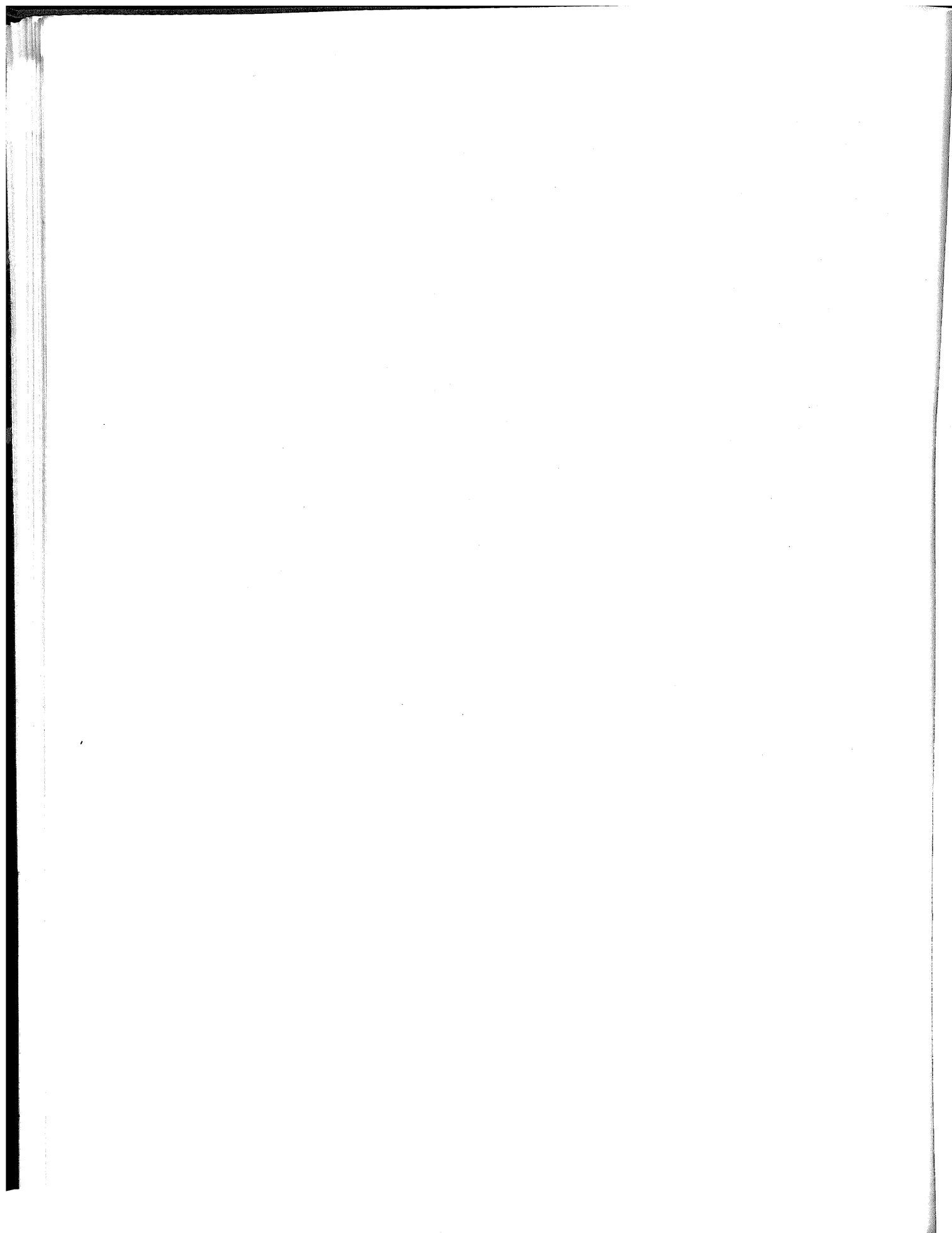
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University Psychiatric Clinic, Wilh. Klein Str. 27, Basle, Switzerland

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USAMC Intern Training Center-USALMC Attn:

AMXMC-ITC-E-S, Red River Army Depot, Texarkana, Tex. 75501

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HS-017 794

Victoria Police Dept., Melbourne, Australia

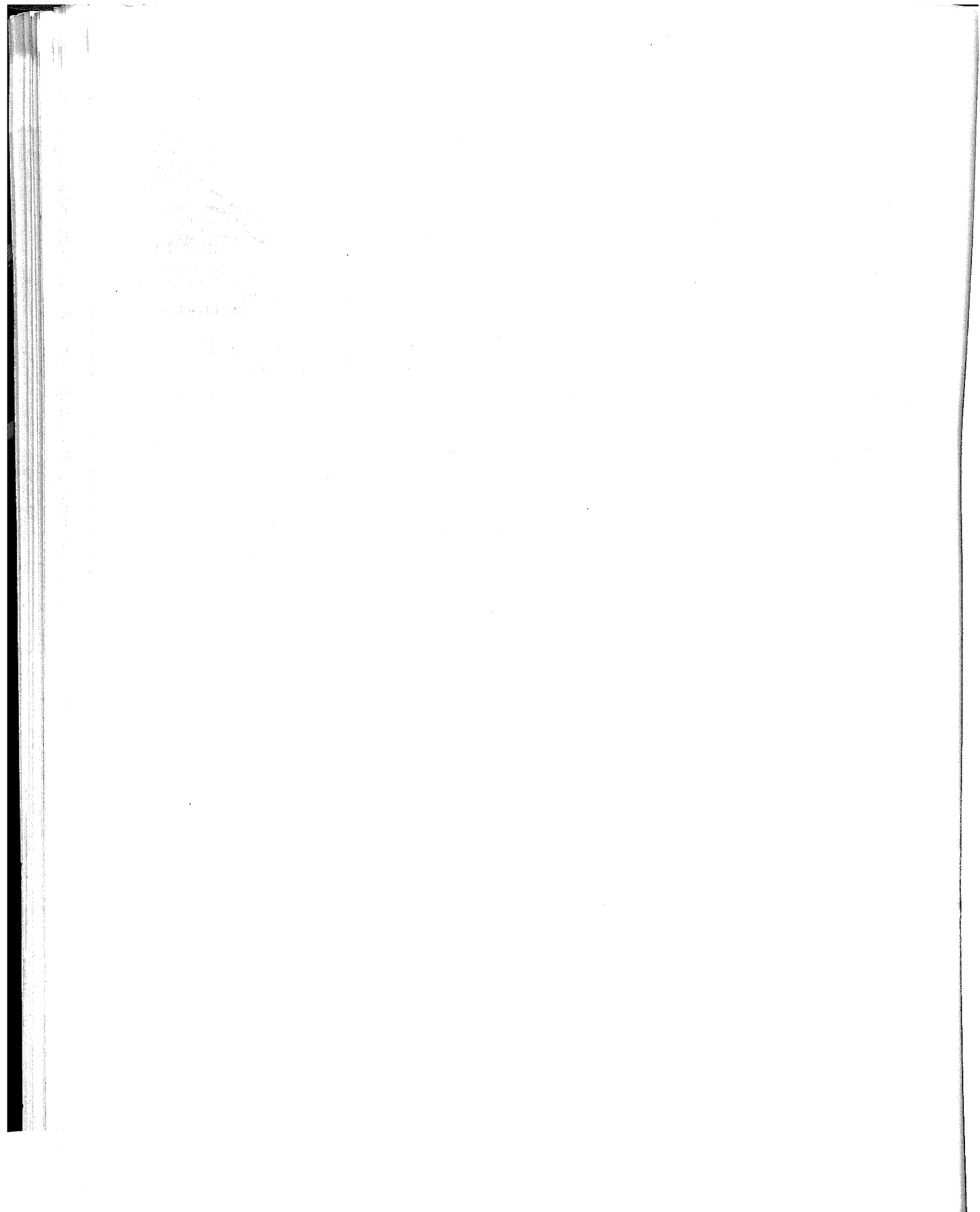
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TRRL-LR-622	HS-017 842	39/75	HS-017 829
TRRL-LR-678	HS-017 841	3942-75-159	HS-801 748
TRRL-Supp-77-UC	HS-017 806	43/75	HS-017 828
UCLA-ENG-7455	HS-017 943	6510-75-98	HS-801 754
UM-HSRI-BI-75-6	HS-017 939	6910-75-68	HS-801 753
1/75	HS-017 834	7/75	HS-017 833
12/75	HS-017 832	75-1568, 75-1785	HS-017 835

## **CONTRACTS AWARDED**

DOT-HS-034-3-535 Mod. 8.

**TRI-LEVEL STUDY OF THE CAUSES OF TRAFFIC ACCIDENTS**

Increased \$88,769.00.

Indiana University Foundation, Box F, Bloomington, Ind. 47401

Extended to 20 Nov 1976

DOT-HS-137-3-648 Mod. 3.

**TECHNICAL AND OPERATIONAL ASSISTANCE - FATALITY ANALYSIS FILE**

Increased \$2,647.00.

Genasys Corporation, 4853 Cordell Ave., Suite A10, Bethesda, Md. 20014

Extended to 5 Jul 74

DOT-HS-157-2-247 Mod. 16.

**ALCOHOL SAFETY ACTION PROJECT**

Decreased \$188,513.00.

Department of Public Safety, Division of Alcohol Safety, 9 E. Loockerman Street, Treadwear Towers, Dover, Del. 19901

Extended to 30 Jan 1976

DOT-HS-191-3-759 Mod. 3.

**EVALUATION OF ALCOHOL SAFETY ACTION PROJECT REHABILITATION EFFORTS**

Increased \$45,111.00. 0

University of South Dakota, Vermillion, S.D. 57069

Extended to 30 Jun 1976

DOT-HS-237-2-406 Mod. 6.

**FATALITY ACCIDENT RECORDS SYSTEM (FAIRS)**

Increased \$15,000.00. eas

State of South Carolina, State Highway Department, Drawer 191, Columbia, S.C. 29202

Extended to 31 Dec 1976

DOT-HS-245-2-428 Mod. 7.

**FATALITY ACCIDENT RECORDS SYSTEM (FAIRS)**

Increased \$3,000.00.

State of New York, Department of Motor Vehicles, Division of R&D, South Mall, Albany, N.Y. 12228

No Change

DOT-HS-316-3-604 Mod. 4.

**FATALITY ACCIDENT RECORDS SYSTEM (FAIRS)**

Increased \$8,400.00.

State of Arizona, Arizona Highway Department, 206 South 17th St., Phoenix, Ariz. 85007.

No Change

DOT-HS-4-00853 Mod. 6.

**HANDLING TEST PROCEDURES FOR LIGHT TRUCKS, VANS AND RECREATIONAL VEHICLES**

Increased \$6,999.00

Ultrasystems, Inc., Dynamic Sciences Division, 1850 W. Pinnacle Peak Rd., Phoenix, Ariz. 85027

To be completed two (2) months from date of modification

DOT-HS-4-00921 Mod. 4.

**QUANTIFICATION OF THORACIC RESPONSE AND INJURY**

Increased \$10,375.00

Regents of the University of Michigan, Office of Research Administration, Ann Arbor, Michigan 48104

No Change

DOT-HS-4-00955 Mod. 2.

**EXPERIMENTAL FIELD TEST OF PROPOSED ANTI-DART-OUT TRAINING PROGRAMS**

Increased \$55,142.00

Applied Science Associates, Inc., Box 158, Valencia, Butler County, Pa. 16059

Extended to 1 Mar 1977



DOT-HS-4-00970 Mod. 4.

DOT-HS-4-00970 Mod. 4.

**TRAFFIC OFFENSE SENTENCING PROCESSING  
AND HIGHWAY SAFETY**

Increased \$11,339.53

Public Systems, Inc., 1137 Kern Ave., Sunnyvale, Calif. 94086

Extended to 19 Mar 1976

DOT-HS-5-01037 Mod. 3.

**DIAGNOSTIC MOTOR VEHICLE INSPECTION  
DEMONSTRATION PROJECTS PROGRAM  
ENGINEERING SUPPORT**

Increased \$14,930.00. 01 c

AVCO Systems Division, 201 Lowell St., Wilmington, Mass.  
01887

No change

DOT-HS-5-01037 Mod. 4.

**DISGNOSTIC MOTOR VEHICLE INSPECTION  
DEMONSTRATION PROJECTS PROGRAM  
ENGINEERING SUPPORT**

Increased \$261,301.00.

AVCO Systems Division, 201 Lowell St., Wilmington, Mass.  
01887

To be completed no later than twenty-five (25) months after  
the effective date of the contract.

DOT-HS-5-01039 Mod. 4.

**SAFETY BELT INTERLOCK SYSTEM USAGE  
SURVEY**

Increased \$3,090.00

Opinion Research Corporation, North Harrison St., Princeton,  
N.J. 08540

No change

DOT-HS-5-01092 Mod. 1.

**IMPLEMENTATION AND OPERATION OF  
FACILITY ACCIDENT FILE**

Increased \$22,611.28.

HSL 76-05

State of Connecticut, Department of Motor Vehicles, 60 State  
St., Wethersfield, Conn. 06109

No change

DOT-HS-5-01124 Mod. 3.

**MATHEMATICAL RECONSTRUCTION OF  
ACCIDENTS**

Increased \$24,871.00.

Calspan Corporation P.O. Box 235 Buffalo, N.Y. 14221

Extended to 30 Jun 1976

DOT-HS-5-01127 Del. Order 3.

**COMPLIANCE TESTING--TIRES**

\$1,300.00

Compliance Tensting, Inc. 1150 N. Freedom St. Ravenna,  
Ohio 44266

No change

DOT-HS-5-01141 Mod. 1.

**A STUDY OF THE RELATIONSHIP AMONG  
FATIGUES, HOURS OF SERVICE AND SAFER  
OPERATIONS. PHASE II**

Increased \$20,990.00

Human Factors Research, Inc. Santa Barbara Research Park  
6780 Cortona Dr. Goleta, Calif. 93017

No change

DOT-HS-5-01163 Mod. 2.

**URBAN CROSSING PROBLEMS**

Increased \$93,968.00.

Applied Science Associates, Inc. Post Office Box 158  
Valencia, Butler County, Pa. 16059

No change

DOT-HS-5-01241 Mod. 1.

**SELF TEST DEVICES**

Increased \$5,821.00.

May 31, 1976

DOT-HS-6-01310.

Dunlap & Associates, Inc. One Parkland Drive Darien, Conn.  
06620

No change

DOT-HS-5-01243 Mod. 2.

**TRAFFIC SAFETY PROGRAM MANAGEMENT  
FELLOWSHIP AND INTERNSHIP - MODEL  
PROGRAM DEVELOPMENT**

Increased \$60,000.00

University of Southern California University Park Los  
Angeles, Calif. 90007

No change

DOT-HS-5-01249 Mod. 2.

**COORDINATION CENTER HIGHWAY SAFETY  
COMMUNICATIONS**

Increased \$29,993. 01No

Grey Advertising, Inc. 777 Third Avenue New York (New  
York County), N.Y. 10017

No change

DOT-HS-5-01266 Mod. 1.

**ACCIDENT ANALYSIS - BREAKAWAY AND NON-  
BREAKAWAY POLES INCLUDING SIGN AND  
LIGHT STANDARDS ALONG HIGHWAYS**

Increased \$200,000.00.

Southwest Research Institute 8500 Culebra Rd. San Antonio,  
Tex. 78284

No change

DOT-HS-6-01279 Del. Order 2.

**RENTAL OF STORAGE SPACE**

\$1,285.64.

Victory Van Corporation 950 South Pickett St. Alexandria, Va.  
22304

1 Sep. to 30 Sep. 1975

DOT-HS-6-01292.

**PEDESTRIAN-BICYCLIST ACCIDENT DATA  
SAMPLING AND ANALYSIS PROGRAM (PADSAP)**

\$306,011.00

The Mitre Corporation 1820 Dolley Madison Blvd., McLean,  
Va. 22101

To be completed 15 months from date of contract award

DOT-HS-6-01297.

**INTERACTIVE DATA FILE, VEHICLE/PEDESTRIAN  
COLLISIONS**

\$16,284.00

Small Business Administration Washington, District Office  
1030 15th St., N.W. Washington, D.C. 20417. "This contract is  
awarded by the Small Business Administration under the  
authority of Section 8(a) of the Small Business Act (USC  
637a), and will be administered by the Department of  
Transportation, National Highway Traffic Safety  
Administration "

DOT-HS-6-01300.

**VALIDATION OF CRASH VICTI**

\$409,106

Calspan Corporation 4455 Genesee St. Buffalo, N.Y. 14221

To be completed by 21 Jul 1977

DOT-HS-6-01309.

**INVESTIGATION OF AIR CUSHION RESTRAINT  
SYSTEM (ACRS) ACCIDENTS (SOUTHWEST  
REGION)**

\$65,103.00

Southwest Research Institute 8500 Culebra Rd. San Antonio,  
Tex. 78284

To be completed 31 Dec. 1976

DOT-HS-6-01310.

**RECALL CAMPAIGN AUDITS**

\$60,510.00

DOT-HS-6-01314.

McDonnell Douglas Automation Company 2990 Telestar Ct.  
Falls Church, Va. 22042

To be completed one (1) year from date of contract award

DOT-HS-6-01314.

**INVESTIGATION OF AIR CUSHION RESTRAINT  
SYSTEM (ACRS) ACCIDENTS (FAR WEST REGION)**

\$29,472.00

University of Southern California University Park Los  
Angeles, Calif. 90007

To be completed 31 Dec. 1976

DOT-HS-6-01315.

**INVESTIGATION OF AIR CUSHION RESTRAINT  
SYSTEM (ACRS) ACCIDENTS (SOUTHEAST  
REGION)**

\$86,140.00

University of Miami P.O. Box 248293 Coral Gables, Fla. 33124

HSL 76-05

To be completed 31 Dec. 1976

DOT-HS-6-01318.

**SNOW TIRE TEST PROGRAM**

\$22,700.00

Hodges Transportation, Inc. Nevada Automotive Test Center  
P.O. Box 234 Carson City, Nev. 89701

To be completed by 28 Feb 1977

DOT-HS-6-01327.

**FARS COMPUTER REWRITE SYSTEM**

\$56,700.00

Control Data Corporation 6003 Executive Blvd. Rockville,  
Md. 20852

To be completed by 3 May 1976

# THE NATIONAL HIGHWAY SAFETY NEEDS REPORT

## EXECUTIVE SUMMARY\*

### I. INTRODUCTION

In his Statement of National Transportation Policy, Secretary William T. Coleman, Jr. noted that an abiding dilemma plagues the public decisionmaker who seeks to make the most effective use of limited resources. It lies, he wrote,

"in the paucity of information by which to gauge what improved levels of performance may be realized with different expenditure levels . . . . In the past, we have been unable to project with any degree of precision where the government can realize the most benefits for the next marginal dollar of expenditure or what aggregate national benefits can be realized at any predetermined level of expenditure."\*\*

This report demonstrates the value of such improved information. In particular, it shows how a cost effectiveness analytical framework can facilitate the process of highway safety administration and more effective allocation of resources.

It should be emphasized at the outset, however, that this report does not give us definitive answers to the needs of the highway safety program. Our state of understanding is not strong enough to do that. Rather, the report provides our best estimates of national costs and benefits on the basis of available data which is seriously deficient in some important aspects. It must be underscored that any judgments inferred from the data, or any decisions predicated on it should be made only after the caveats presented in Section 1.3 of Chapter I have been closely read and carefully considered. (See Appendix A.)

Nevertheless, even at the level of coarse comparisons, substantive insights and conclusions emerge that are useful to the government decisionmaker. The

analysis enables us to focus attention to those areas in which resource allocation may be most susceptible to improvement; it demonstrates how a linkage may be drawn between goals and funding; and it illustrates why the optimal allocation of highway safety resources can best be accomplished at the State level, providing a prototype procedure by which this might be done.

Few areas are more deserving of our constant quest for management improvement. The cost of highway accidents is staggering: even after the recent dramatic improvement in our highway safety record, 46,000 lives were lost and over 2½ million injuries were suffered last year. Government has been mobilized at all levels to solve this problem of safety on our nation's highways and in doing so spends \$7.25 billion per year. The present analysis seeks to make more effective use of this expenditure, to save additional lives and further reduce injuries, without impairing these essential links for interstate commerce and travel.

This report is in response to a directive by the Congress to provide the basis for evaluating the continuing highway safety programs authorized under Title 23, USC. Therefore it deals primarily with Highway Safety Programs and Highway Safety Construction Programs. Complementary areas of concern which fall under other titles of the U.S. Code, particularly those dealing with vehicular safety, (occupant protection systems such as air bags, or improved crashworthiness of individual vehicles) are not dealt with here, although they are of no less importance in reducing fatalities and injuries.

### II. APPROACH

The cause and effect relationships which lead to death or injury on the highway are neither simple nor apparent. Most are the result of a complex series of interactions and circumstances in which the driver, the vehicle, the highway or any combination of them can be at fault. Tracing these contributory factors and mitigating their effects is a complex undertaking which is greatly hampered by a lack of adequate data.

\* This summary is an excerpt from a Report of the Secretary of Transportation to the U.S. Congress pursuant to Section 225 of the Highway Safety Act of 1973.

\*\* U.S. Department of Transportation, *Statement of National Transportation Policy*, September 1975, p. 22.

The approach taken was to examine the pattern of expected fatalities and injuries for the next 10 years in order to isolate major problem areas and to assemble and evaluate countermeasures that may be effective in dealing with them. For the highway safety aspects of the problem (as opposed to the vehicular safety aspects) thirteen problem areas were identified, including bad driver behavior (a major portion of which is the drinking driver), roadside hazards, bicycle and pedestrian safety, young drivers and motorcycles. For each such problem area a list of potential countermeasures was developed; a list which numbered over 200 originally, and was eventually narrowed to the 37 deemed to offer the highest promise of reducing future highway fatalities and injuries.

### III. PROJECTIONS

The number of highway traffic deaths in the United States increased from about 48,000 in 1965 to 55,000 in 1969 and remained near that level until 1973. In 1974 the number of traffic deaths decreased to 46,000. This dramatic decrease was apparently due to the reduced number of miles traveled and the imposition of the 55 mile per hour speed limit, which was adopted to conserve fuel. The number of fatalities in 1975 was about the same as in 1974.

Assuming that national highway safety efforts will continue at current levels with traffic speeds remaining near the 1974 level, it is estimated that the number of traffic deaths will rise to about 56,000 in 1986. This will be the result of a steady increase in population (from 212 million in 1974 to 233 million in 1986), licensed drivers (from 125 to 152 million), registered vehicles (from 135 to 169 million), and highway travel (from 1.29 trillion to 1.68 trillion vehicle miles). The increase includes higher motorcycle fatalities (from 3 to 6 thousand), pedestrian fatalities (from 9 to 10 thousand), and bicyclist fatalities (from 1 to 2 thousand).

Increases are also forecast for the additional contributing factors of per capita consumption of alcohol and usage of compact and subcompact automobiles. With no additional emphasis on highway safety, it is anticipated that the traffic fatality rate will probably remain at about the present 3.4 fatalities per 100 million vehicle-miles of travel for the next 10 years.

Traffic accidents resulting in injury are also expected to increase during the period through 1986 (from 1.8 million to 2.1 million). Injury accidents

rose from about 1.5 million in 1965 to a peak of 1.9 million and then dropped slightly during the energy crisis. The injury accident rate per 100 million vehicle miles dropped from 170 to 137 in 1974. This rate is expected to continue, provided that the current levels of safety program efforts and traffic speeds remain constant. Property damage accidents are also forecast to increase from 14 to 16 million.

### IV. COUNTERMEASURES

In spite of high expenditures on highway safety at all levels of government, and notwithstanding the gains achieved over the last 10 years, traffic deaths and injuries are expected to continue in tragic proportions. Since many highway safety countermeasures are already partially in use, the analysis is conducted in terms of incremental deployments over the next 10 years. This requires estimating both their incremental effects and their incremental costs.

The effectiveness of a countermeasure depends upon two factors: its own unique value as a deterrent (of either the number of accidents or their severity) and the size of the population affected by its deployment. The deterrent values have been estimated through reference to experiments and tests that appear in the literature. Although carefully sifted so that only empirical or statistical data possessing some degree of scientific objectivity were used, the deterrent values remain, for the most part, highly judgmental. The size of the population affected was estimated from mass statistics or sample surveys available through the Department of Transportation or the National Safety Council, and either raw or analyzed State traffic statistics. A panel of experts was also employed to augment the effectiveness estimates developed.

Figure 1 shows the estimated relative potential to forestall fatalities and injury accidents on a national basis over the next 10 years for 37 countermeasures. Mandatory Safety Belt Usage, heightened enforcement of the Nationwide 55 mph Speed Limit, and Combined Alcohol Safety Action Countermeasures each have the potential to forestall tens of thousands of fatalities over the next 10 years. Their potential to forestall injury accidents is even greater. The estimates indicate that Mandatory Safety Belt Usage could forestall 3.2 million injury accidents, and stronger enforcement of the Nationwide 55 mph Speed Limit could avoid about 415,000 injury accidents. Thirteen of the first fifteen countermeasures in the list have the capacity to forestall hundreds of thousands of such accidents.

The costs of the countermeasures were estimated on a national scale, on the basis of survey data acquired by interviews with officials in 20 States and 593 local jurisdictions. Based on this sample, it was possible to estimate the costs of new deployments of each countermeasure, recognizing initial costs, capital costs, recurring costs, and user costs. All costs are estimated in constant 1974 dollars over a 10-year period, and converted to their present value equivalent using a 10 percent discount rate. Capital costs are adjusted when the service life extends beyond the 10-year period. The time frame for implementation in the individual States for different countermeasures will be quite disparate. This also was recognized and taken into consideration in both the conversion to present value equivalent and in the estimates of effects over the next 10 years.

The countermeasures are ranked by costs in Figure 2. These costs are for incremental deployments. While some portion of these deployments may be implemented by the States during the normal course of their ongoing programs, for the most part the costs represented would be over and above current government expenditures. In present value terms, the total for all incremental deployments of countermeasures is almost \$42 billion. This is approximately comparable to a flow of \$6.8 billion in constant dollars for each of the next 10 years. When coupled with present expenditures on highway safety, these costs are greatly in excess of the levels the Nation had previously chosen to spend on highway safety.

## V. EVALUATION IN COST EFFECTIVENESS TERMS

From the estimates presented thus far, it is apparent that (1) the costs for implementing all countermeasures are high, and (2) that there is a vast difference in the relative effectiveness of different countermeasures. Clearly, there is a need to select among countermeasure deployments and to develop a methodology by which this selection can be made on a systematic basis. In the present study, a procedure for doing this at the national level is demonstrated using the estimated national averages provided in Figures 1 and 2. It is also pointed out, however, that the procedure will yield different, though equally valid, results at the State level.

Figure 3 arrays the 37 countermeasures in order of diminishing cost effectiveness. Fatalities Forestalled is used as the measure of effectiveness and for purposes of simplicity the remaining discussion will be couched in those terms, although the procedure can be applied

as well on a basis of injury accidents or property damage accidents forestalled. It may be seen that there is considerable variation in the number of lives that may be saved for a given expenditure. (The reader is reminded again that all the numerical values presented are estimates and subject to the caveats stated in Chapter I, Section 1.3.)

The top ranking countermeasure, Mandatory Safety Belt Usage, has the potential to save 89,000 lives over the next 10 years, at a cost of only \$45 million. It thus requires the expenditure of only \$506 for each fatality forestalled.

Increased enforcement of the Nationwide 55 mph Speed Limit has the second highest potential to save additional lives, almost 32,000, but is not the second most cost effective; it ranks fourth.

At the other extreme, improvements in Roadway Alignment and Gradient in selected high accident locations have the potential to save less than 600 lives, and would do so at a cost of \$4.5 billion. This countermeasure thus requires an expenditure of \$7.68 million for each fatality forestalled.

On the basis of coarse comparisons, the top ranking countermeasure is 15,000 times as cost effective in preventing fatalities as the poorest, and the second best is almost 300 times as cost effective as the second poorest. The results are even more disparate when comparing the relative cost effectiveness in forestalling injury accidents. Clearly, there is much to be gained in making the proper choices about how countermeasure priorities are to be set and how highway safety funds are to be allocated.

The cost effectiveness ordering of Figure 3 will not necessarily appear in the same sequence in the individual States. This is because the data used here is in the form of national statistical aggregates. Among States or even within a State, a deployment at one site will produce a different result than a deployment at another. As a case in point, both the effects and costs of a countermeasure will be different in a populous urban setting than in a rural one, yet they have been averaged in the above data.

Nevertheless, the procedure demonstrated with national averages can be applied to expenditures of highway safety funds at the State level. The data presented with this report, revised by each State to reflect the conditions unique to its own opportunities for deployment, (particularly the size of the driving population affected) will enable each State to make up its own version of Figure 3. Further, the States have the ability to assess each countermeasure deployment at the individual project level, and can develop

FIGURE 1

**RANKING OF COUNTERMEASURES BY DECREASING POTENTIAL TO FORESTALL  
FATALITIES AND INJURY ACCIDENTS - 10-YEAR TOTAL**

COUNTERMEASURE		FATALITIES FORESTALLED (A)	INJURY ACCIDENTS FORESTALLED (B)
1.	Mandatory Safety Belt Usage	89,000	3,220,000
2.	Nationwide 55 mph Speed Limit	31,900	415,000
3.	Combined Alcohol Safety Action Countermeasures	13,000	153,000
4.	Combined Emergency Medical Countermeasures	8,000	146,000
5.	Selective Traffic Enforcement	7,560	296,000
6.	Impact Absorbing Roadside Safety Devices	6,780	158,000
7.	Tire and Braking System Safety Critical Inspection-Selective	4,590	180,000
8.	Citizen Assistance of Crash Victims	3,750	0
9.	Skid Resistance	3,740	195,000
10.	Regulatory and Warning Signs	3,670	143,000
11.	Upgrade Traffic Signals and Systems	3,400	133,000
12.	Breakaway Sign and Lighting Supports	3,250	127,000
13.	Guardrail	3,160	52,800
14.	Upgrade Education and Training for Beginning Drivers	3,050	131,000
15.	Driver Improvement Schools	2,470	113,000
16.	Periodic Motor Vehicle Inspection-Current Practice	1,840	71,900
17.	Bridge Rails and Parapets	1,520	15,300
18.	Pedestrian and Bicycle Visibility Enhancement	1,440	24,200
19.	Bridge Widening	1,330	51,000
20.	Selective Access Control for Safety	1,300	50,300
21.	Motorcycle Rider Safety Helmets	1,150	14,400
22.	Paved or Stabilized Shoulders	928	35,800
23.	Wrong-Way Entry Avoidance Techniques	779	3,290
24.	Roadway Lighting	759	29,600
25.	Driver Improvement Schools for Young Offenders	692	27,000
26.	Upgrade Bicycle and Pedestrian Safety Curriculum Offerings	649	11,200
27.	Traffic Channelization	645	31,500
28.	Roadway Alignment and Gradient	590	23,000
29.	Clear Roadside Recovery Area	533	20,700
30.	Median Barriers	529	2,740
31.	Pedestrian Safety Information and Education	490	19,200
32.	Intersection Sight Distance	468	18,300
33.	Highway Construction and Maintenance Practices	459	18,000
34.	Railroad-Highway Grade Crossing Protection (Automatic gates excluded)	276	1,080
35.	Pavement Markings and Delineators	237	9,210
36.	Warning Letters to Problem Drivers	192	3,760
37.	Motorcycle Lights-On Practice	65	1,680

NOTE: All figures have been rounded to three significant digits after internal computations were completed. All figures are subject to the caveats concerning precision of the data discussed in Chapter I, Section 1.3.

FIGURE 2

**RANKING OF COUNTERMEASURES BY INCREASING COST OF IMPLEMENTATION  
IN PRESENT VALUE DOLLARS - 10-YEAR TOTAL**

COUNTERMEASURE		COST (\$ millions)
1.	Motorcycle Lights-On Practice	5.2
2.	Highway Construction and Maintenance Practices	9.2
3.	Upgrade Bicycle and Pedestrian Safety Curriculum Offerings	13.2
4.	Pedestrian Safety Information and Education	18.0
5.	Driver Improvement Schools for Young Offenders	36.0
6.	Wrong-Way Entry Avoidance Techniques	38.5
7.	Mandatory Safety Belt Usage	45.0
8.	Warning Letters to Problem Drivers	50.5
9.	Driver Improvement Schools	53.0
10.	Motorcycle Rider Safety Helmets	61.2
11.	Bridge Rails and Parapets	69.8
12.	Guardrail	108.0
13.	Median Barriers	121.0
14.	Regulatory and Warning Signs	125.0
15.	Clear Roadside Recovery Area	151.0
16.	Skid Resistance	158.0
17.	Intersection Sight Distance	196.0
18.	Pedestrian and Bicycle Visibility Enhancement	---
19.	Breakaway Sign and Lighting Supports	
20.	Pavement Markings and Delineators	
21.	Nationwide 55 mph Speed Limit	
22.	Roadway Lighting	
23.	Impact Absorbing Roadside Safety Devices	
24.	Citizen Assistance of Crash Victims	
25.	Railroad-Highway Grade Crossing Protection (Automatic gates excluded)	
26.	Selective Traffic Enforcement	
27.	Traffic Channelization	
28.	Tire and Braking System Safety Critical Inspection--Selective	
29.	Upgrade Education and Training for Beginning Drivers	1
30.	Upgrade Traffic Signals and Systems	2,000.0
31.	Combined Alcohol Safety Action Countermeasures	2,130.0
32.	Selective Access Control for Safety	3,780.0
33.	Periodic Motor Vehicle Inspection--Current Practice	3,890.0
34.	Combined Emergency Medical Countermeasures	4,300.0
35.	Roadway Alignment and Gradient	4,530.0
36.	Bridge Widening	4,600.0
37.	Paved or Stabilized Shoulders	5,380.0
Total		41,600.0

NOTE: All figures have been rounded to three significant digits after internal computations were completed.  
All figures are subject to the caveats concerning precision of the data discussed in Chapter I, Section 1.3.



FIGURE 3

RANKING OF COUNTERMEASURES BY DECREASING COST EFFECTIVENESS IN PRESENT VALUE DOLLARS  
PER TOTAL FATALITIES FORESTALLED - 10-YEAR TOTAL

COUNTERMEASURE	FATALITIES FORESTALLED (A)	COST (\$ millions) (B)	DOLLARS PER FATALITY FORESTALLED (C)
1. Mandatory Safety Belt Usage	89,000	45.0	506
2. Highway Construction and Maintenance Practices	459	9.2	20,000
3. Upgrade Bicycle and Pedestrian Safety Curriculum Offerings	649	13.2	20,400
4. Nationwide 55 mph Speed Limit	31,900	676.0	21,200
5. Driver Improvement Schools	2,470	53.0	21,400
6. Regulatory and Warning Signs	3,670	125.0	34,000
7. Guardrail	3,160	108.0	34,100
8. Pedestrian Safety Information and Education	490	18.0	36,800
9. Skid Resistance	3,740	158.0	42,200
10. Bridge Rails and Parapets	1,520	69.8	46,000
11. Wrong-Way Entry Avoidance Techniques	779	38.5	49,400
12. Driver Improvement Schools for Young Offenders	692	36.3	52,500
13. Motorcycle Rider Safety Helmets	1,150	61.2	53,300
14. Motorcycle Lights-On Practice	65	5.2	80,600
15. Impact Absorbing Roadside Safety Devices	6,780	735.0	108,000
16. Breakaway Sign and Lighting Supports	3,250	379.0	116,000
17. Selective Traffic Enforcement	7,560	1,010.0	133,000
18. Combined Alcohol Safety Action Countermeasures	13,000	2,130.0	164,000
19. Citizen Assistance of Crash Victims	3,750	784.0	209,000
20. Median Barriers	529	121.0	228,000
21. Pedestrian and Bicycle Visibility Enhancement	1,440	332.0	230,000
22. Tire and Braking System Safety Critical Inspection-Selective	4,591	1,150.0	251,000
23. Warning Letters to Problem Drivers	192	50.5	263,000
24. Clear Roadside Recovery Area	533	151.0	284,000
25. Upgrade Education and Training for Beginning Drivers	3,050	1,170.0	385,000
26. Intersection Sight Distance	468	196.0	420,000
27. Combined Emergency Medical Countermeasures	8,000	4,300.0	538,000
28. Upgrade Traffic Signals and Systems	3,400	2,080.0	610,000
29. Roadway Lighting	759	710.0	936,000
30. Traffic Channelization	645	1,080.0	1,680,000
31. Periodic Motor Vehicle Inspection-Current Practice	1,840	3,890.0	2,120,000
32. Pavement Markings and Delineators	237	639.0	2,700,000
33. Selective Access Control for Safety	1,300	3,780.0	2,910,000
34. Bridge Widening	1,330	4,600.0	3,460,000
35. Railroad-Highway Grade Crossing Protection (Automatic gates excluded)	276	974.0	3,530,000
36. Paved or Stabilized Shoulders	928	5,380.0	5,800,000
37. Roadway Alignment and Gradient	590	4,530.0	7,680,000

NOTE: All figures have been rounded to three significant digits after internal computations were completed. All figures are subject to the caveats concerning precision of the data discussed in Chapter 1, Section 1.3.

their rank ordering on a project-by-project basis, rather than on a basis of expected national experience, as has been done here. An effort of this type would draw heavily on the improved systems management and support programs which have received considerable emphasis in the States in recent years.

Figure 4 extends the concept of efficiency one step further; it presents the aggregate effects which might be expected where many countermeasures are deployed. The figure shows two horizontal axes representing different types of costs. The upper scale of the horizontal axis, Scale A, is in total 10-year present value costs, in the same terms as the costs of Figures 2 and 3. The lower scale of the horizontal axis, Scale B, depicts the equivalent annual costs in constant 1974 dollars. The vertical axis is in the same terms as the fatalities forestalled of Figures 1 and 3.

The upper curve, Curve 1, shows how the national costs will rise cumulatively and how the fatalities they might be expected to forestall will also rise cumulatively, as the countermeasures are successively implemented in cost effective sequence. It may be seen that the curve falls off to the right, as the most effective countermeasures are used up, and only the less effective remain. At each point of the curve, its slope represents the marginal return on the public dollar, or the increment of lives saved for the next dollar invested.

For highway safety at the national level, it may be argued that the expenditure achieves the largest overall return if the countermeasures are given funding priority proceeding from the left. This will be true providing we continue to deal with national averages, the effects of each countermeasure are independent of the others, and fatalities forestalled is the measure of dominant concern. Curve 1 of Figure 4, is based upon the data in Figure 3, but has been adjusted to avoid double counting.

It has already been noted that safety belt usage is the single most effective safety alternative which can presently be deployed. Its significance is illustrated graphically in Figure 4. Assume for discussion purposes that a funding stream of \$1.5 billion per year were to become available for deployment of new countermeasures. (While it is not clear how much funding will be available for these new deployments, this assumption would appear rational if the \$1 billion in present Federal funds were to become free in a relatively short time and be matched by another \$.5 billion from the States.) This level is denoted on Scale B of the horizontal axis by its intersection with Line C, which also intersects Curve 1 at Point C<sub>1</sub>.

The interpretation of Point C<sub>1</sub> is that if \$1.5 billion were available each year to support the set of countermeasures shown, and if the money were to be spent most efficiently, and if the figures were precise, we should expect to save approximately 159,000 lives over the next 10 years, or about 15,900 fatalities forestalled per year.

This result is the theoretical implication of the data. Philosophical and political problems associated with public acceptance of some countermeasures have not been taken into account. Nor is it recognized that the projected number of traffic deaths of 56,000 for 1986 cited in Section II already has implicit in it some assumptions about what proportion of these incremental countermeasures will be deployed as part of the \$7.25 billion presently being spent in highway safety nationwide. Thus, two points must be made clear: (1) that this is an isolated part of the total savings of life which may be assumed from an expenditure of an isolated portion of all of the funds, and (2) the figure of 15,900 assumes the use of the most cost effective countermeasures examined in this study including Mandatory Safety Belt Usage.

Curve 2 on Figure 4 plots the same data as Curve 1 with Mandatory Safety Belt Usage excluded. It may

an expenditure of

It may be seen that

able national goal would

stalled, or approximately 10

tory Safety Belt Usage. Point

cates that without Mandatory Safety

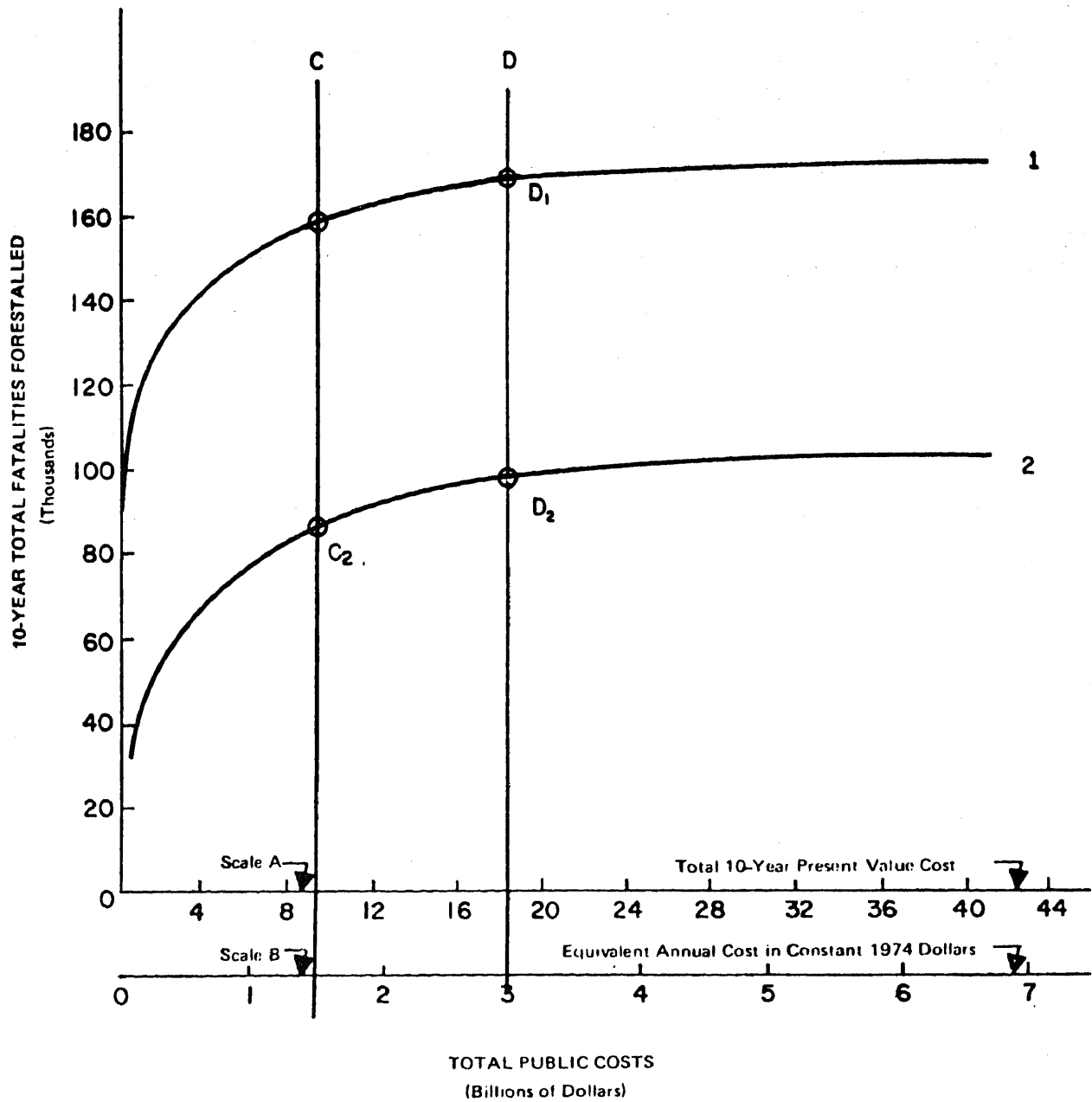
might expect only 98,000 fatalities

9,800 per year.

The projected difference between Curves 1 and 2 also assumes that the resources will be judiciously spent. The cost effectiveness array of Figure 3 indicated that an investment in one countermeasure may have the capacity to save ten, 100, or even 1,000 times as many lives as when placed in another. In fact, any in the top five of the list appear to be at least 100 times as cost effective as any in the bottom six of the list. The marginal return concept has the capacity to play a unique role in this respect because it may be interpreted as a criterion, or a very coarse guideline, as to what constitutes an acceptable investment at that level of expenditure. At the \$1.5 billion

FIGURE 4

**PLOT OF CUMULATIVE FATALITIES FORESTALLED AND CUMULATIVE PUBLIC COSTS**  
**(Benefits Reduced by Effects of Countermeasures Previously Employed)**



per year funding level, the marginal return at Points  $C_1$  and  $C_2$  is of interest; they establish an average national criterion of \$462,000 to forestall a fatality. In the absence of any other considerations, countermeasure deployments would not be justifiable which require more expenditure than that amount, because at that level of funding there exist too many other better deployment opportunities which would result in the savings of more lives for the same or a smaller amount of investment. At the \$3 billion per year funding level, the marginal return for Points  $D_1$  and  $D_2$  is of interest, and they establish an average criterion of over \$2 million to forestall each fatality.

It is to be expected that for each countermeasure, even those which rank poorly on the basis of national aggregates, such as Paved or Stabilized Shoulders and Bridge Widening, there will be some unique deployments (i.e., one specific segment of highway to be augmented with paved shoulders, or one specific bridge to be widened) that will outperform the national criterion. However, because it represents an upper limit which properly should not be exceeded if the anticipated benefits in forestalled fatalities and injuries are to be realized by the funding stream chosen, the use of such a criterion will encourage only the most efficient applications from all countermeasure categories.

A similar criterion for evaluating alternative countermeasure deployments would have to be set at the State level, based on the funds available to that State and the opportunities available to it to deploy countermeasures within its own jurisdiction. This criterion, stated in terms of fatalities forestalled for each dollar invested, would be unique for each State. The shape of their curves will be comparable with those of Figure 4 but the cost effective ordering may produce a different ranking sequence.

The above procedure must be applicable to a dynamic setting, always capable of adapting to better information as it becomes available, and not stultifying the adoption of additional candidate countermeasures when they are ready for deployment. A number of countermeasures now under extensive trial are believed to be very effective, but no significant data is yet available for them. The fact that the benefits of these particular countermeasures were insufficiently quantifiable to be ranked in the figures does not imply that they are ineffective or unworthy of continued consideration. Rather, it indicates that testing must be continued to establish with more certainty their actual worth.

## VI. CONCLUSIONS

A number of countermeasures examined in this study result in social benefits beyond those directly associated with highway safety, such as the conservation of energy (55 mph program), improved response times for all community emergencies (Emergency Response Command and Control Systems), more prompt and forceful recognition of problem drinkers (Combined Alcohol Safety Action Countermeasures), improved traffic capacity and travel speeds, and improved security and crime deterrence. No attempt has been made to incorporate these benefits in the effectiveness values used in this report, although they do figure substantially in public investment decisions and in some cases may be as important as the highway safety benefits.

"Needs" have meaning in the strict sense only if they can be defined in the context of established safety goals and their achievement. The identification of needs therefore requires the identification of problems and concomitant solutions; i.e., needs must ultimately be translated into deficiencies which, when remedied, will directly or indirectly reduce the traffic toll by some desired amount. This report constitutes a rational approach to the problem of highway safety needs. It has also shown that severe information deficiencies exist, making very difficult a reliable estimate of such needs.

Three countermeasures have the estimated potential

... The other,   
 termeasures,   
 list. The drinking   
 health problem; he is involved in a disproportionately high percentage of fatal accidents. The interpretation for the middle ranking for alcohol safety action countermeasures is that the problem remains very large, but we have not yet found very cost effective ways of meeting it, and must continue to seek them.

The methodology described here can most advantageously be employed at the State level because the States are best able to assess and rank any countermeasure deployment in terms of applicability at a given site, the size of the population affected, physical highway conditions, special budgetary and/or political circumstances, and its integration with other complementary countermeasures in effect or being planned. The capacity of the States to execute such a procedure however, has never been demonstrated.

## VII. RECOMMENDATIONS

Both Federal and State governments should actively promote the universal use of safety belts.

Both Federal and State governments should continue to seek strong uniform enforcement of the National 55 mph Speed Limit.

Pilot tests of the analytic approach carried out in this study should be conducted in several States to verify the feasibility of such a technique at the State level and to assess its usefulness as a planning tool.

A more rigorous means should be developed, using this study as a point of departure, for stating goals, identifying needs, and measuring concomitant results within a changing traffic safety setting. Concentration should be on improving the process of counter-measure development and its evaluation. The States should emphasize the application of evaluation meth-

odologies to their annual and multi-year planning processes and continue to refine the data base from which reliable accident exposure and target population estimates must be made.

Guam, American Samoa, and the U.S. Virgin Islands, have highway safety needs which are significantly different from those of the 50 States. While a start has been made in recent years toward solving the distinct problems of these Territories, the report proposes accelerated measures for these jurisdictions.

National safety performance should be reviewed in the framework indicated in this report on a periodic basis.

NOTE.—Copies of the complete National Highway Safety Needs Report may be purchased from: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Order Stock No. 050-000-00110-5. \$2.25.

## APPENDIX A

### 1.3 Caveats Governing the Presentation of This Report

Three blanket caveats should be viewed as being applicable throughout this document and essential for the reader to bear in mind as each data item or statement is examined.

#### 1.3.1 *Caveat 1—Governing the Estimates of Fatality and Injury Reductions Through the Application of Various Countermeasures*

For purposes of this report, and the analytical framework it introduces, the expected effects of each countermeasure have been reduced to one single-valued estimate. These estimates were made by professionals in the field, on the basis of the information available to them.<sup>1</sup> It must be borne in mind by the reader that these cause and effect relationships, although they appear to be empirical, may in fact be very subjective. Further, this single value represents a guide or a benchmark for comparison purposes, but cannot portray the expected range of variations resulting from different applications. It is somewhat analagous to the single-valued miles-per-gallon estimates appearing on all new automobiles, which become a guide for comparing their relative gasoline efficiency, but cannot portray the variations which will be expected due to unit options, local highway conditions and individual driver behavior.

#### 1.3.2 *Caveat 2—Governing the Conversion of Estimates of Countermeasure Effectiveness to Expected National Experience*

There are two potential pitfalls in making estimates of countermeasure effectiveness on a national scale. The first is that the research and experimentation which led to the effectiveness estimate was usually conducted on a limited scale, sometimes in several

States, but often in less. The generalization of these results to what would be expected as a national experience requires conclusions which extrapolate beyond the range of the data, and all such extrapolations are risky. Secondly, the effectiveness of any countermeasure is highly dependent upon the specific characteristics of the site where it is employed, or to what segment of the driving population it is aimed. It is also dependent upon what other complementary countermeasures may be in effect.

For these reasons, any estimates of effectiveness at a national scale must be conditioned with the recognition that these are anticipated average results. In actual practice a countermeasure deployed in one State may produce different results than in another. Within a State deployment at some sites may produce different results than deployment at other sites. Therefore, the findings presented below on a national basis cannot be viewed as prescriptive for the individual States. Rather, they represent guidance on how the States can most efficiently manage their own safety programs.

#### 1.3.3 *Caveat 3—Governing What Benefits and Costs are Recognized*

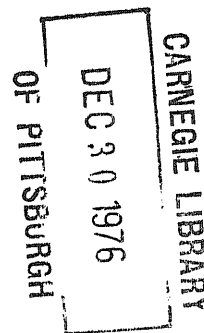
It is required that this report evaluate the costs and options available for a given highway safety program, assess the comparative merits of each countermeasure, and it is necessary that each be examined in terms of a common framework: the costs it will entail and the benefits it will produce in terms of fatalities and accidents forestalled over the next decade. These options must, of course, be based on improving the system now in being. Therefore, each alternative countermeasure is examined in terms of its potential as an increment to the present system. Each is viewed in terms of how it may be incrementally deployed from 1977 to 1986; the costs identified are incremental costs attributable to that added deployment, the benefits identified are those that result from that added deployment.

<sup>1</sup> The rationale for these estimates may be found in Appendix A of the complete report. It cites the sources used, the numerical inputs to the estimate and notes the quality of the data upon which the estimates are based. Two samples of that material appear in Appendix 3 of the complete report.

The analysis is oriented toward highway safety only. The comparisons made are concerned solely with safety costs and safety benefits. Safety costs include public monies for capital expenditures, for start-up costs, and for recurring costs. They include also the incremental costs which the user must pay as a result of new deployments of the countermeasure. If some countermeasures entail other societal costs, they have not been explicitly recognized. The safety benefits are only those of fatalities and accidents forestalled. Although deployment of some countermeasures may result in other external societal benefits, no attempt has been made to add them to the numerical tabulation.<sup>2</sup>

<sup>2</sup> Section 6.6 of the complete report briefly lists some of the spillover benefits associated with selected countermeasures.

Because the above caveats do prevail, the importance of this report is not that it identifies specific countermeasures for implementation, but that (1) it presents a methodology that can be used for improving the use of highway safety resources and for countermeasure development and (2) it provides coarse rankings of the relative effectiveness of the different countermeasures on a national scale. Although in actual application, the analysis will require detailed and objective data at the State and local levels, supported by indepth research and demonstration not available for this report, the comparative national rankings do provide at least preliminary estimates and guidance to those concerned with highway safety management as to what overall experience might be expected for most States.



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